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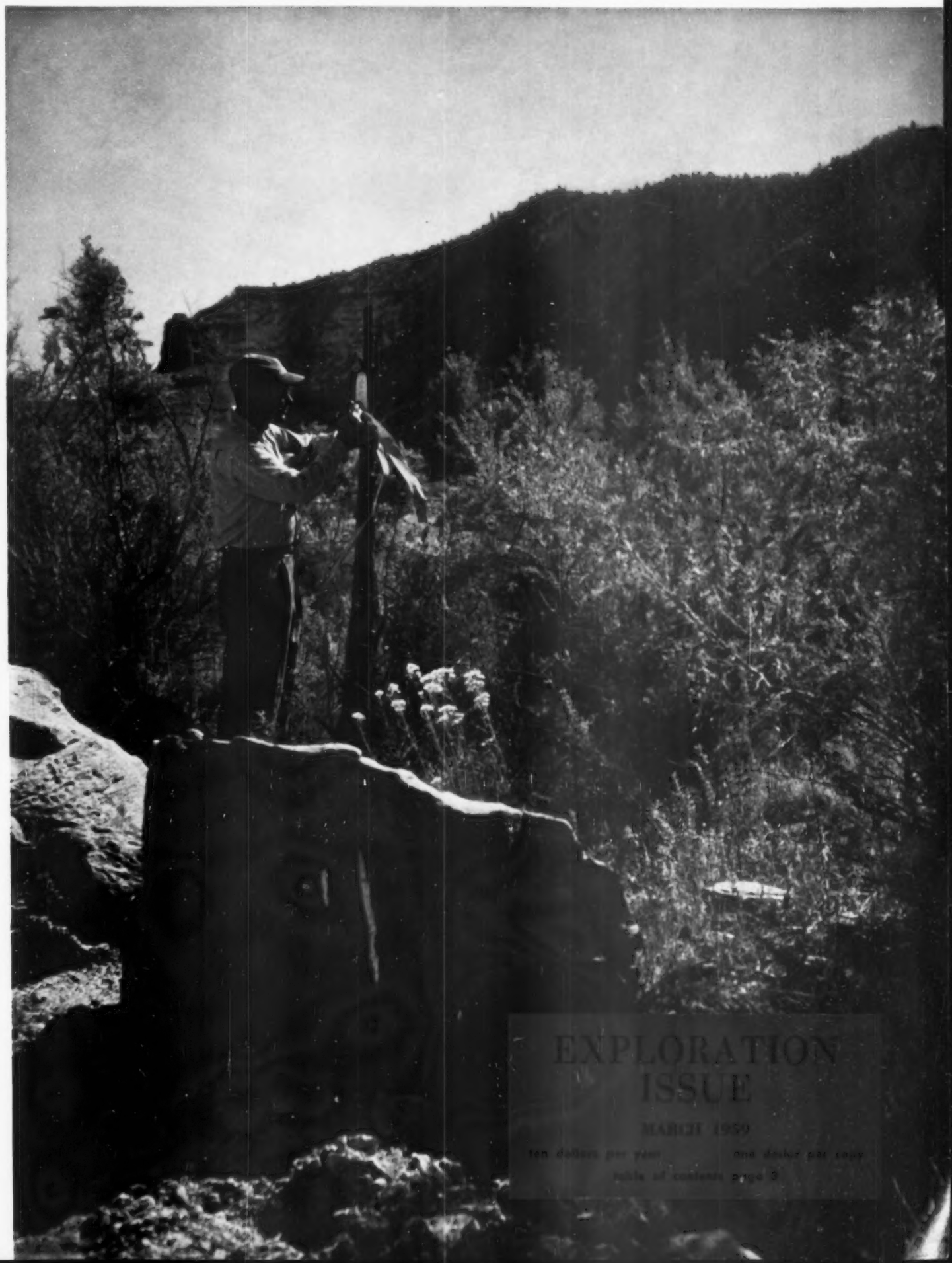

EXPLORATION ISSUE

MARCH 1959

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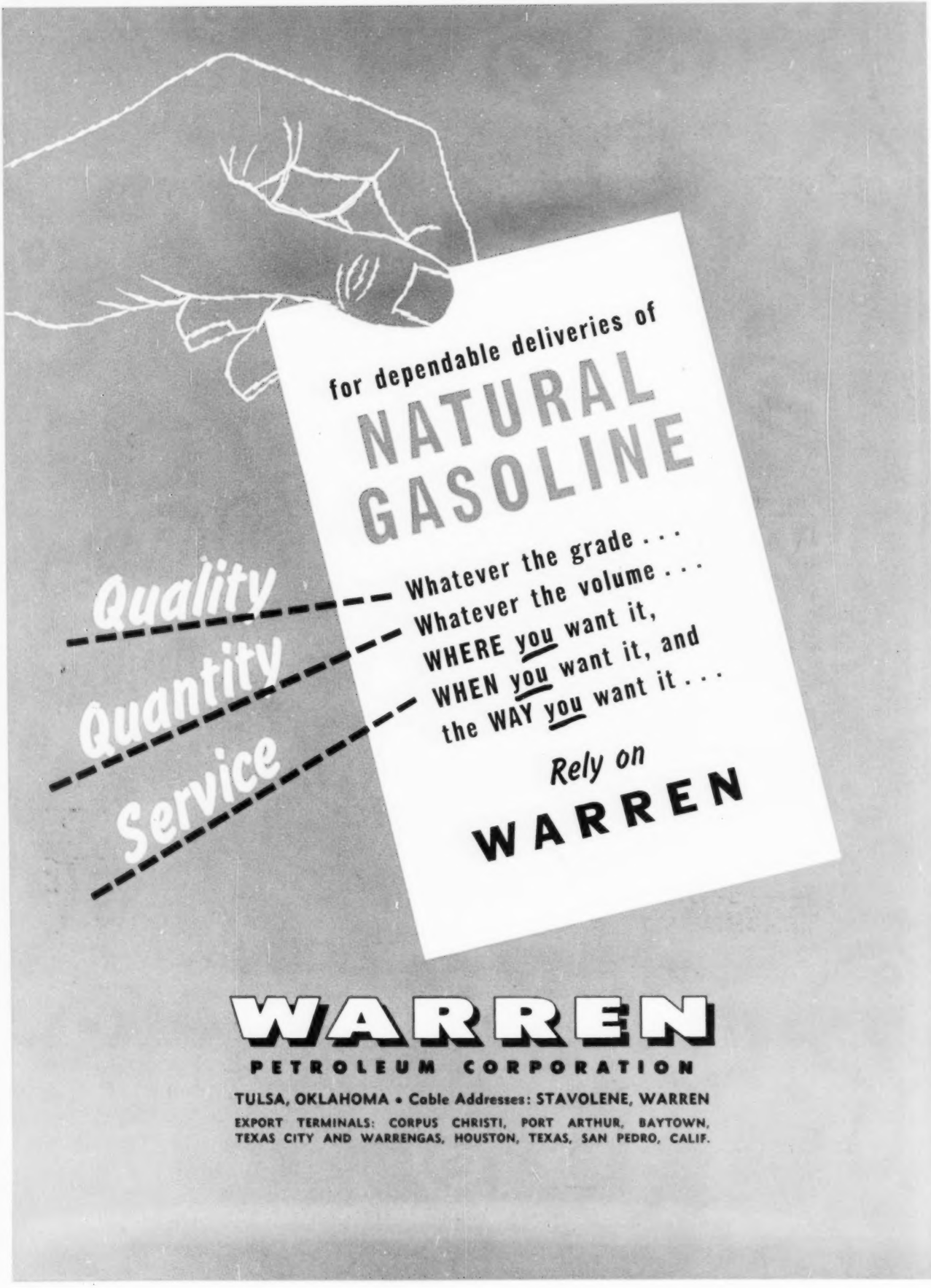

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World Petroleum

THE MANAGEMENT PUBLICATION OF THE INTERNATIONAL PETROLEUM INDUSTRY

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THIS MONTH'S COVER

Marking a seismograph shot hole in the Northwest. Color plates are reproduced through the courtesy of William H. Walsh, editor of *Service*, house magazine of Cities Service Company.

Washington Pipeline

By Joseph B. Huttlinger

The tipoff that the Eisenhower administration is leaning toward a mandatory program to control imports of crude oil and of oil products came as officials moved to plug a legal loophole. The Secretaries of State and Defense asked for a new certification that imports both of crude and of products actually are a threat to USA national security. The action came, it was explained, after assertions of the Department of Justice that the new finding is necessary if a mandatory program is to stand up in the courts.

DJ explained that the first certification, April 1957, covered only crude oil, so another is needed if products are to be included. And, DJ said, it would like a more recent crude certification. With a deadline of February 28 set for expiration of the current voluntary program, USA officials saw the need for swift action. But, they pointed out, the procedures for a certification take 90 days. To handle this, the Office of Civil and Defense Mobilization changed its rules to provide that, when a government agency asks a certification, the matter can be handled in 30 days. OCDM issues certifications.

The request of the State and Defense Departments reopened the entire matter once again, to the surprise of many in the oil industry. Both sides—those for sharp curbs on imports and those for no curbs—again filed statements with OCDM. There was little enthusiasm in the filings, however.

"After all, they seem to have made up their minds," said one oil-company official opposed to import curbs. "I think we'll hold our punch until we go to court against the import curbs."

Under the change in the rules and the timing of the State-Defense request, the OCDM could have issued a certification by February 27, one day before the deadline. With the cabinet committee on oil imports poised to act once the certification is handed down, the deadline could be met.

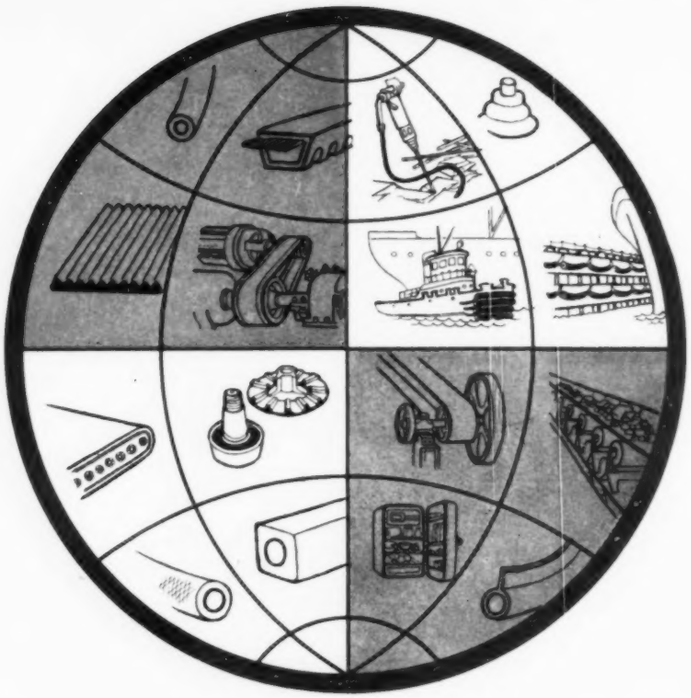
Congress, meanwhile, was taking a look at the whole effort to limit imports. Senator Joseph C. O'Mahoney (D., Wyo.) began to set up a hearing shortly after Congress opened in January. He said this is a matter for the Congress to handle, adding the delay within the administration proves that the executive branch of the government cannot handle the situation. O'Mahoney called high officials of government to the Senate Interior Subcommittee on Public Lands, of which he is the chairman.

A rash of bills is in the hopper, meanwhile, for further curbs on oil imports. Chances are for no legislation on the subject, if the cabinet committee is able to come up with an effective program which stands up in the courts.

Committee Favors Depletion

There's one piece of good news in the fight to preserve the income-tax depletion allowance for crude-oil and natural-gas production. The new Senate Finance Committee breaks down 13 to four in favor of the allowance at the present rate of 27.5%.

(Continued on page 6)



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Washington Pipeline

(Continued from page 4)

Six new members were added to the committee and, whether by design or accident—probably the former—five of them are on record in favor of depletion at the present rate. This is significant, as the Senate likes to heed the advice of its tax-writing committee before taking action to change tax laws.

Senate Committee Democrats for the 27.5% rate include: Chairman Harry F. Byrd (Virginia); Robert S. Kerr (Oklahoma); J. Allen Frear, Jr. (Delaware); Russell B. Long (Louisiana); George A. Smathers (Florida); Clinton B. Anderson (New Mexico); Herman Talmadge (Georgia); R. Vance Hartke (Indiana).

Senate Committee Republicans for the 27.5 rate include Frank Carlson (Kansas); Wallace F. Bennett (Utah); John Marshall Butler (Maryland); Norris Cotton (New Hampshire); and Carl Curtis (Nebraska).

Senate Committee Democrats opposed include Paul H. Douglas (Illinois); Albert Gore (Tennessee); and Eugene McCarthy (Minnesota). Senate Committee Republican opposed is John J. Williams (Delaware).

On the House side, where tax legislation usually originates, no similar count is possible, as it has been many years since the House had a roll-call vote on the depletion provision. It is widely known, however, that the House Ways and Means Committee, which writes the tax laws, is less kindly toward the depletion allowance than is its Senate counterpart. The House committee, however, has vast respect for House Speaker Sam Rayburn (D., Texas), and tries to follow his lead. So, it would be unusual for the committee to report out a measure to slash the allowance when Rayburn is ardently for the allowance.

Oil men watching depletion see the provision in as grave danger today as at any time since the depletion became part of the tax laws. This is so because individual House members and, more particularly Senate members, often have a chance to offer amendments to tax bills when they reach the floor.

Senators John J. Williams (R. Del.); William Proxmire (D., Wisc.); and Paul Douglas (D., Ill.) in fact are just waiting for a tax bill to hit the floor of the Senate. Then they plan to line up senators to back them in trying to get an amendment to it.

If an amendment should pass in the Senate, the bill would go to the House, giving the House a chance to vote on the matter directly. Under usual procedure, tax bills reach the House floor from the committee under a closed rule; i.e., no amendments can be offered from the floor of the House.

Oil men are uncertain that they would find a majority of the senators backing up a 27.5% rate for depletion; they are certain that the full House, in a free vote, would decide that the allowance has been too generous to oil men. Odds are the Senate, itself, in a free vote, would turn back an attack on depletion by a narrow margin.

Another Gas-Bill Setback

The drive for a natural-gas bill, to ease up federal price and other controls over independent producers of gas, took a heavy setback in January. President Eisenhower, who two years ago asked Congress for a gas bill in his budget message, ignored the subject in his message to the opening of the 86th Congress. There was no official explanation for the President's failure to include a gas bill in his list of recommendations to the Congress.

Secretary of the Treasury Robert B. Anderson told a press conference he does not know why it was left out, but he doubted the President had changed his mind on the need for the bill. Another high official speculated that the President probably thought it "futile" to again ask for a gas bill. He explained that the last Congress could have given him a bill, but didn't, probably because it lacked the votes to pass one. The current Congress, he added, is widely regarded as even less friendly toward a bill which is assailed as one to raise gas prices to the consumer.

Chairman Oren Harris (D., Ark.) of the House Commerce Committee, again introduced his gas bill, this time revamped to win votes of some 20-odd House members from coal states. The changes would forbid "dump" sales by gas pipelines for industrial use.

Federal Power Commission officials, meanwhile, are going ahead with price control over independent producers on the theory there will be no gas bill. This is an about-face, as there is some evidence that the FPC was marking time hoping to be freed of the job of figuring out a fair way to handle this control.

Protest Gas-Tax Rise

President Eisenhower raised a storm of protest when he proposed a hike in the federal gasoline tax of 1.5 cents a gallon for five years starting next July 1. This would raise the federal tax to 4.5 cents a gallon. Auto and petroleum industries led the parade of protests, with officials of more than half the states objecting that the gasoline tax is their hunting ground for highway revenue.

In the Congress, which will decide, the reception was cool. House Speaker Sam Rayburn (D., Texas) said it "will be pretty hard" for the administration to get what it seeks. The idea, he said, is meeting "a pretty cold reception in the states." Senate Majority Leader Lyndon Johnson (D., Texas) said he is "unwilling to travel this road" of "more and more sales taxes, first on gasoline, then on other essentials and finally on everything."

Secretary of the Treasury Robert B. Aderson said the extra 1.5 cents would bring in an added $690 million the first year, $884 million the second year, and $919 million the third. Without more revenue, he said, the highway fund faces a deficit.

Highway users are paying $1.5 billion in taxes annually, chiefly on automobiles, which do not go into the highway trust fund. The natural question is why not put those into the fund? Anderson replied "we would simply have the problem of saying where are we going to get the other billion and a half dollars which goes into the revenue fund."

Pending the completion of a Bureau of Public Roads study on the entire subject of highways and whom they benefit and who should pay, due in 1961, Anderson said "we simply resorted to increasing those taxes which now contribute to the highway fund as a means of bringing about additional revenue."

Naval Reserve Disposal

President Eisenhower wants to get out of the petroleum-producing business, but the Congress may not allow it. In his budget message to Congress, the President said the whole idea of trying to lock up oil in naval petroleum reserves is "anachronistic."

The President said "it would appear that the nationwide, even worldwide, petroleum industry must be relied upon to provide efficiently for our petroleum requirements both in peace and war." So, he said, "the administration will study (and I would hope the Congress would do likewise) the advisability of disposing" of our reserves.

The proposal drew little praise at the US capitol, where the subject of petroleum reserves is highly sensitive ever since the bribery charges stemming from the Teapot Dome days. Chairman Carl M. Vinson (D., Ga.) of the House Armed Services Committee, which handles oil reserves, flatly rejected the idea. He said the USA needs the reserves in order to have oil "in the ground" for use in the event of an emergency. Vinson, meanwhile, has again proposed a bill to set up a fifth naval oil reserve on San Nicolas, San Miguel, and Prince Islands off the coast of California. In view of the White House desire to dispose of what reserves the USA has, the Vinson bill seems to face a veto even if it were to pass in the Congress.

Senator Joseph C. O'Mahoney (D., Wyo.), leader of the Western Democrats in Congress, told the Senate "the sentiment of the company would be against the sale of these reserves to private interests." A staunch advocate of civilian control over government property, O'Mahoney put in a bill, however, to transfer the naval reserves to the Department of the Interior for leasing out to private companies under the Mineral Leasing Act of 1920. Senator Gale McGee (D., Wyo.) joined O'Mahoney in the bill.

Senator E. L. Bartlett (D., Alaska), meanwhile, put in a bill to transfer Naval Reserve No. 4, in Alaska, to the Department of the Interior for leasing out to private oil companies. If this were passed, he promised, he'd back up the Vinson bill for a new reserve on San Nicolas Island.

The USA has about 880 million barrels of oil in four reserves, which produce about 5,300,000 bbl a year and bring in revenues of about $14,500,000 a year. The reserves are at Elk Hills, Calif.; Buena Vista Hills, Calif.; Teapot Dome, Wyo.; and in the north of Alaska. Only one is worthy of the name reserve, and that is Elk Hills, which has about 700 million barrels of oil in the ground and produces only about 15,000 b/d. Production at Buena Vista is handled with no attempt to save oil in the ground, and there is little or no production at the other reserves.

The problem of reserves has been a headache for the Navy and its director of petroleum reserves, Captain A. S. Miller. The Navy has had to step up production when oil operators nearby sunk wells nearby and threatened to drain the Navy's oil. The Navy has had the troubles stemming from a unit-operation plan in the Elk Hills Reserve. And, the Navy has had trouble selling its oil. Last year it had to resort to a barter deal—Elk Hills crude for Standard's residual oil.

Fowler Resigns

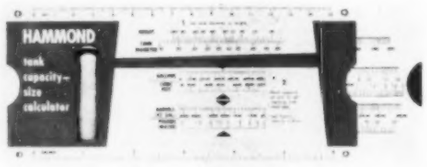
Ralph S. Fowler, assistant director of the Office of Oil and Gas, Department of the Interior, left the government at the end of January to join The Pure Oil Co. A search was on for a successor.

Mr. Fowler is to be in New York for awhile, and then go abroad. He formerly worked for the Arabian American Oil Co., as a lawyer, and joined the Department of the Interior, September 1956. He gave up business as a private consultant on petroleum to join the government. During the Suez crisis, he was director of the voluntary agreement.

Big Inch Pipe Exports

The US Commerce Department refuses to approve export to Russia of steel pipe larger than 24-in.-diameter, officials explain. Thus, they turned down a request by an American firm to export 12,000 tons of 28-in. to 30-in. pipe to Russia on the grounds the pipe would have strategic value.

Officials refused to name the American firm which applied to export the pipe, or any details other than the rejection.



Tank-Capacity Slide Rule

A pocket-size slide-rule calculator for determining capacity and size of storage tanks is now available from Hammond Iron Works, 744 Broad Street, Newark, N.J.

The new Hammond slide-rule calculator furnishes information on tanks up to 100 ft high and 300 ft in diameter. Capacities are given in gallons, barrels, and pounds of water. Additional information obtainable with the Hammond calculator includes: decimal equivalents of a foot for all inch units and fractions; equivalent volumetric units: and steel-plate weights for thicknesses from 3/16-in. to 1-in.

The Hammond calculator can be obtained from Hammond Iron Works, Warren, Pa.

New Viscocity Standards

As of January 1, 1959, the American Petroleum Institute discontinued its three viscosity standards —Alpha, Betta, and Gamma. Under sponsorship of the American Socy. for Testing Materials, Cannon Instrument Co., State College, Pa., will furnish seven new oil standards for viscometer calibration. API said the 1958 versions of *ASTM Tentative Method D:* 445 Kinematic Viscosity; and *Standard Method D 88:* Saybolt Viscosity, will refer to the new series.

Signal-Hancock Merger

Stockholders of Signal Oil and Gas Co. and Hancock Oil Co. have voted to merge the two firms on a share-for-share basis. As result of merger, Signal will have a 50% interest in a 28,000-acre concession in Lake Maracaibo, Venezuela. Signal and Hancock each owns 25% in the mid-lake concession, of which Signal is the operator.

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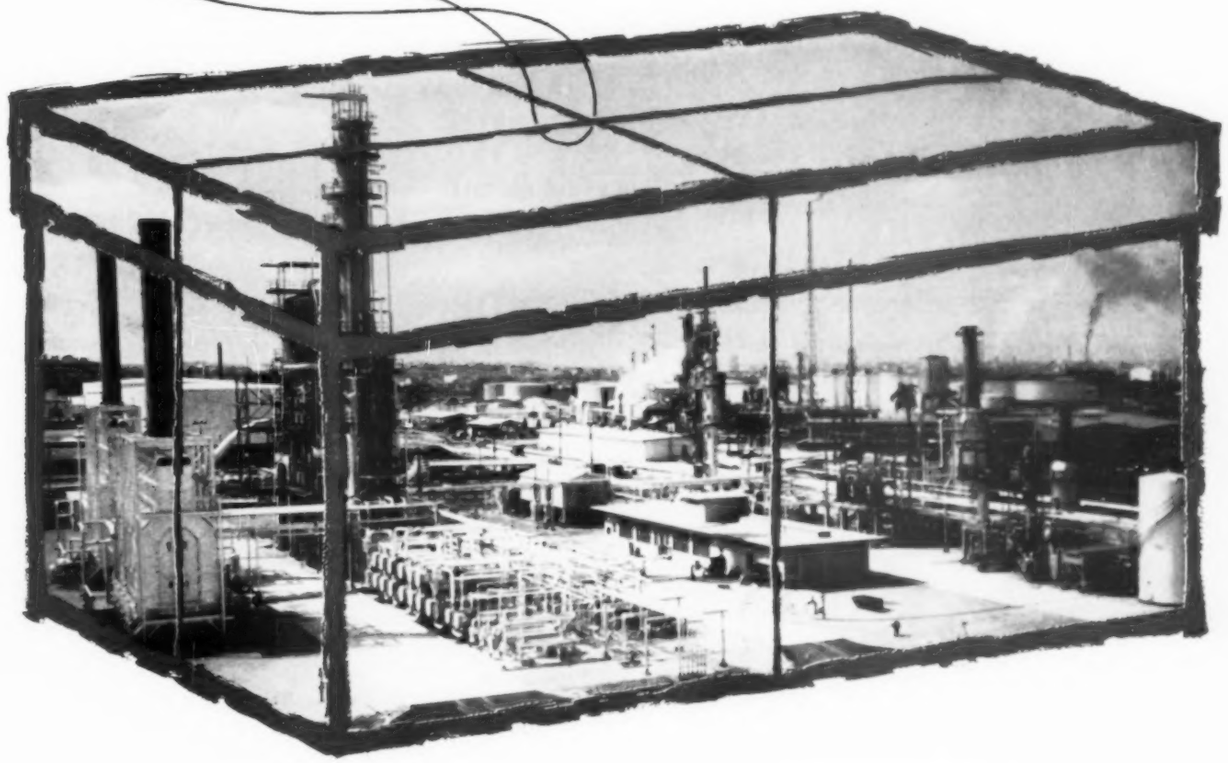

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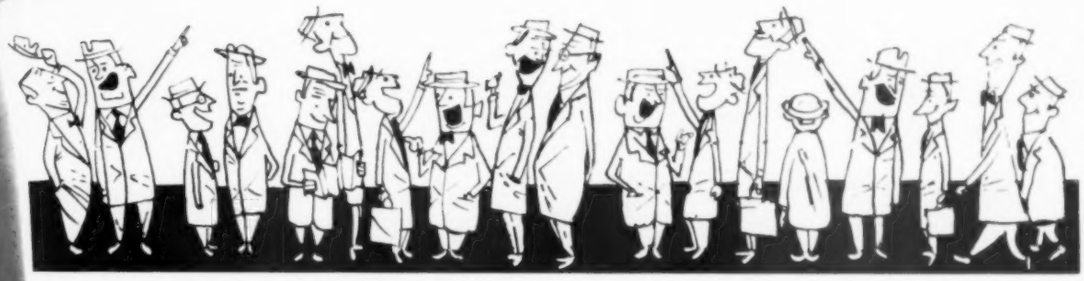

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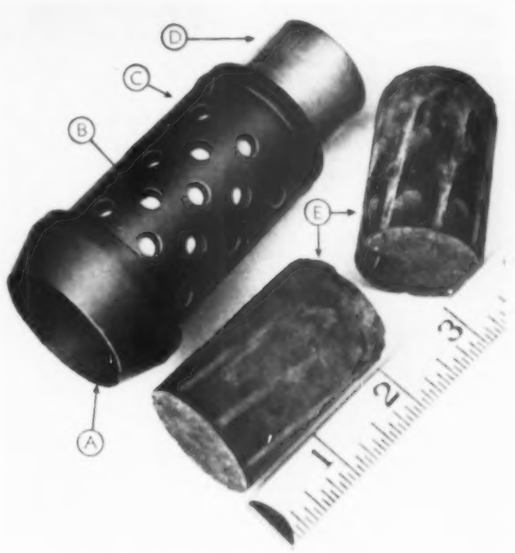

(Right) PGAC's 32-shot Jumbo sidewall coring tool.
(Above) PGAC sidewall coring projectile and cores: A — Cutter; B — Mud extrusion ports; C — Core barrels; D — Powder chamber and retrieving cable housing; E — Large PGAC Jumbo Cores.

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LONDON LETTER

By Cecil W. Wood

BP Tanker Financing

British Petroleum Co. and Houlder Brothers Co. Ltd. have jointly formed a new company—Warwick Tanker Co. Ltd.—with a fully paid capital of £500,000 to take over and finance the shipbuilding contracts costing over £5 million for two 35,000 dwt tankers previously on order in UK yards for BP, with completion set for March and July 1960. The tankers will be chartered to BP Tanker Co. British Petroleum representatives on the Warwick Tanker board are A. E. C. Drake, CBE (director, British Petroleum); J. Houston Jackson (managing director, BP Tanker Co.) and R. Gillespie, CBE (director, B.P. Tanker Co.). This means that British Petroleum has now secured £57 million outside finance towards its large building program over the past two years for tankers entering service up to 1960. The problem now is to finance the 26 vessels to be built between 1960 and 1963, costing over £80 million.

Proposed Caltex Refinery

A further step in the long and complicated stage of "clearing the way" of statutory requirements against the time when the proposed Caltex group refinery can be erected at Warsash, on Southampton Water opposite the Fawley refinery, was taken early in January. A Hampshire County Council Planning Committee meeting revealed that 997 acres are now involved, of which 568 are already owned by the company. The application stated that the whole area is not expected to be developed at the start, but is held to be necessary to insure a not unduly restricted layout and room for further expansion. It was also stated that the crude throughput envisaged is two to three tons a year. Stress was laid in the application on the many safeguards to public amenities which would be incorporated. *World Petroleum* understands that the use of only some 300 acres is envisaged at the start, but provision is necessary for possible future expansion into the petrochemical field. Nor has detailed planning yet started, and the throughput mentioned in the application is only of an indicative nature.

The decision of the planning committee is awaited, but at a meeting the day before of the Southampton Corp., the leader of the council and chairman of its planning committee said he had made it clear to the Hampshire County Council Industrial Development Subcommittee that "we are strongly in favor of the refinery," and felt sure the harbor board would welcome the additional shipping it would bring to the port. Actually, approval for the proposed oil jetty has already been given by this board. A recent meeting of the mid-Southern Federation of Trade Council has also offered Caltex "unanimous support." Even so, by reason of the objections of agricultural and other interests in the area, it is likely a public inquiry into the project will be considered necessary.

Monsanto Expansion

Monsanto Chemicals Ltd. announces that 15-million-pound-per-year maleic-anhydride plant will be erected at Newport, Mon., with completion set for the second half of 1960. This will considerably expand the company's production of this organic chemical, giving a surplus for export after meeting all foreseeable requirements of British industry. Affiliates of Scientific Design Co. Inc., of New York, will erect the plant, which will be based on the S.D. process of continuous catalytic vapor-phase air oxidation of benzene.

Another UK Oil Discovery

BP Exploration Co., has struck oil 1½ miles east of Gainsborough, in Lincolnshire, at about 4,600 ft in a well which produced at the rate of 15 tons a day on test. The well is 2½ miles west of the Cottingham discovery of July 1958, and the company is now preparing to delimit this field as well as the Bothamsall (Notts.) field struck earlier last year.

BP oil search in the UK in 1958 was concentrated mainly in areas around the existing east Midland oil fields and in southern England; while the search for natural gas continued on behalf of the gas council. Small gas accumulations were found in several exploration test wells, and there was further development drilling in the Plungar (Leics.) and Egmanton (Notts.) producing oil fields. Their production, together with that of Eakring (Notts.) and Formby (Lancs.), totaled about 80,000 tons in 1958. This compares with 81,926 tons in 1957.

New Kuwait Oil Managing Director

The Hon. William Fraser has been appointed assistant managing director of Kuwait Oil Co. Ltd., and on June 30 next will succeed Sir Philip Southwell, CBE, MC, as managing director. On that date, Sir Philip will relinquish the managing directorship on reaching the normal retiring age, but will remain as a director. During the 12 years he has held the position, his early training in oil-field engineering at Birmingham University, his oil-field experience in several parts of the world, including some years as petroleum technologist to the Trinidad government, and a capacity for hard work have all combined to be of service to the Anglo-American partnership which constitutes Kuwait Oil Co.

Mr. Fraser, a barrister-at-law, has been with British Petroleum Co. since 1950, and is the only son of the former chairman, Lord Strathalmond. He returned recently to England after having been in New York for about two years.

Hon. William Fraser

A. Cluer

Lobitos Refinery Manager

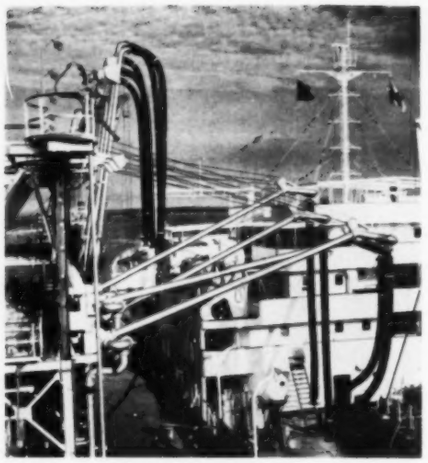
A. Cluer, B.Sc., M. Inst. Pet., formerly process superintendent and assistant manager of Lobitos Oilfield's refinery at Ellesmere Port, has been appointed refinery manager to succeed J. S. Parker, F. Inst. Pet., who retired from that post at the end of 1958, but remains as a consultant. Mr. Cluer has been with the company since 1934.

R. J. Pinder

J. J. Page

Honors For Oil Men

The New Year's Honors List conferred distinctions on a number of British oil men. The rank of Commander of the Most Excellent Order of the British Empire (CBE) was conferred on Reginald J. Pinder, a managing director of Esso Petroleum Co. who joined the company as a clerk in 1920. The rank of Officer of the Order (OBE) has been conferred on H. C. Carrad (general manager of Shell Petroleum in Austria); Capt. J. H. Palmer-Felgate (master of Esso Petroleum's tanker "Esso Canterbury"); C. V. Hill, MC, B.S., F. Inst. Pet. (now adviser on refining to British Petroleum following his recent retirement from the company); and J. J. Page (formerly general manager in Basrah of Basrah Petroleum Co.). Late in 1958, Mr. Page was transferred to the company's London office, where he is now working in the management. Membership of the Order (MBE) was conferred on W. Frank (chief engineer, Shell Tankers Ltd.).



Push-button control for rapid discharge of crude and loading of refined products: Latest type of overhead pipe gantry at two of the modern oil jetties at British Petroleum's Kent refinery allows for a 60-ft rise and fall in a ship's manifold, thus providing for all variations in the tide and of the vessel's depth in the water. Installation can discharge crude at the rate of 2,000 tons or more per hour. On this new jetty, each of the main pipelines from the shore terminates at one of the nine movable booms on the gantry; each of the booms is 36 ft long and each is lifted with a 30-ft-long rubber hose.

Persian Gulf Jetty

Richard Costain Ltd., in association with Raymond World Wide Constructors, have started work in the Persian Gulf on a £4 million jetty, ½ mile long and capable of taking 100,000-ton tankers. The project, which also includes a boat harbor with a rock break water with sheet-steel piles, is being carried out by the Iranian construction group, and is part of the £20 million scheme being supervised for Iranian Oil Exploration and Producing Co. designed to enable Gach Saran production to be greatly increased.

Pipe For Trans-Canada

The congratulations which South Durham Iron and Steel Co. received from Bechtel Corp.'s president at the quality of the pipe received for the Trans-Canada pipeline, and the deliveries thereof, were referred to in the recent annual review of the chairman, B. Chetwynd Talbot. He said the Bechtel president had praised South Durham for "the outstanding part the company had played and the great contribution it had made by supplying several thousands of tons of large-diameter steel pipes." Mr. Talbot said he hoped to attend the official opening ceremony of the pipe line, as he did that of the Westcoast Transmission line. He also revealed that South Durham's pipe line supply contracts to the Middle East had a value of £4½ million in the year ended last September last, and contracts worth over £2.8 million had been secured for 22-in. and 24-in. pipe for Argentina.

Conference On Liquid Fuels

The Institute of Fuel has announced the list of 21 papers to be delivered at its second Conference on Liquid Fuels, to be held at the Palace Hotel, Torquay, from May 11 to 14 next. The central theme of many of the papers will be to review progress and bring up to date the information presented at the institute's highly successful Birmingham conference of 1948.

The following papers are what may be termed 10-year reports: *steel industry* (R. Mayorcas, John Summers Ltd.); *metal industry* (A. B. Pritchard, Shell-Mex and BP; and E. Brett Davies, Midland Tar Distillers); *glass industry* (W. R. Bulcraig, Pikington Bros.); *ceramics industry* (T. Chippingdale, Shell-Mex and BP); *liquid fuel and the gas turbine* (R. F. Darling (PAMETRADA); and *liquid fuel in the manufacture of town gas* (E. R. Ward, South-Eastern Gas Board). Among other papers, C. A. Roast (Esso Petroleum) will discuss works boilers; and G. Whittingham (British Petroleum), packaged boilers. K. H. Sambrook and N. M. Lawrence (Shell Petroleum) will deal with liquid fuels for domestic

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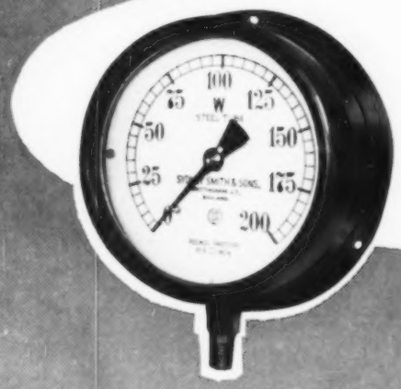

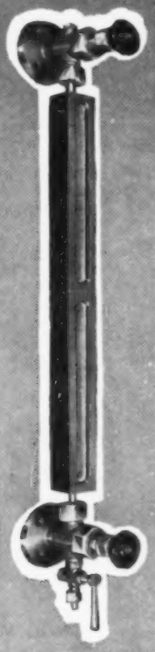

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heating, and other papers will be contributed by members of the oil industry.

The subsequent printed proceedings will be available (price £2. 4s., including postage) from the Institute of Fuel, 18, Devonshire Street, London, W.1.

Expenditure On Research

UK mineral oil refining had 2,944 persons employed on research and technical development in 1955-56, of which 2,725 were full-time; and spent £3,543,000 on such work. This represents 1.9% of the total such expenditure of £183,211,000 by all manufacturing industries. This is revealed in the Department of Scientific and Industrial Research report, "Estimates of Resources Devoted to Scientific and Engineering Research and Development in British Manufacturing Industry, 1955." This is the first report of its kind, and it throws much light on the subject. Replies were sought from establishments employing at least 500 workers, and from a realistic "sample" of those employing less.

It is also assessed that research and development expenditure by the refining industry represented £139.5 per person employed, 1.1% of turnover and 7.5% of net output. From the last of these considerations, oil refining is exceeded only by aircraft manufacture and repair (35.1%), and radio and telecommunications (9.3%). Of the 2,944 research workers, 715 (676 full-time) were scientists, 296 (263 full-time) engineers, and 1,933 (1,787 full-time) were "other employes."

Tankers Save Shipbuilding

The future of British shipbuilding, now seriously exercised by the absence of new orders, would be very much worse but for tankers. According to the shipping conference president, the industry has an order book standing at nearly six million tons gross and worth over £800 million, and three-fifths of this is represented by tankers. Even with this order position, the president of the Chamber of Shipping of the UK has said he reckons at least a million tons of shipping for which orders have been placed may never reach the water. As it is, the UK laid-up position (other than for repair) at December 1, 1958, is reported by the chamber at 957,836 gross tons, including 38 tankers of 317,246 tons. This is the first time idle tonnage has dropped below the million mark since this first was reached July 1 last.

Emphasis on the importance of tankers to British shipping is given by Petroleum Information Bureau's estimate that over 500,000 gross tons of such vessels were completed in UK yards last year—some 35% of all merchant shipping completed. PIB also estimates current tanker orders at about 58% of all tonnage on order.

Lloyd's Register shipbuilding returns show that, at December 31, 1958, there were 71 tankers, of 1,064,195 tons gross, under construction in the UK. This is a decline of 86,376 tons from September 30, and represents 47.6% of the budding of all merchant ships totaling 2,234,158 tons.

At the recent launching of the 36,000 dwt tanker "Esso Portsmouth" from the Walker-on-Tyne yard of Vickers-Armstrong, it was learned that the two 47,000-tonners also on order may be increased in size to "over 70,000 tons." This would make them the largest tankers to be built in the UK, the biggest on order at present being 65,000-tonners for the British Petroleum group. In Germany, the Esso group recently changed an order for four 47,000 tonners to three of 73,000 tons each.

Seven new tankers were launched for BP Tanker Co. in 1958, including four of 42,000 dwt. Two of these have gone into service, and are the largest in the fleet. At end-1958, the company had 48 tankers on order totaling almost two million tons, including 12 of 50,000 tons and seven of 65,000 tons.

British Equipment Notes

A number of "Big Ben" 6 x 4 heavy-duty oil-field trucks supplied by Transport Equipment (Thornycroft) Ltd. to the Shell Co. of Argentina for "off-the-road" operation are at work at Comodoro Rivadavia, both as solo and articulated vehicles. As the former, they carry Ideco Woodfield Hydrair well-servicing units; but, as an articulated vehicle, the tractor is attached to a low-bed multi-wheeler trailer which carries a Wagner Morehouse T-2-37 drawworks unit and a 90-ft telescopic unit. A robust headache rack of tubular construction and a

Closeup of headache rack and Darlington 50,000-lb winch fitted behind cab of Thornycroft "Big Ben" oil-field tractors supplied to Shell Co. of Argentina.

50,000-lb winch are fitted behind the cab. These trucks, when loaded, are capable of climbing gradients up to 10% over rough, stony roads.

Goodyear Pumps Ltd. announces a new portable pump set—the result of the close-coupling of its revolutionary light-weight positive-displacement high-speed size A/7 pump with the Petter P. CI high-speed single-cylinder air-cooled diesel engine to form what is claimed to be the first high-speed positive-displacement portable pumping unit available. The unit will deliver 30 gal per min at a 200-ft head of water, and suctions of up to 27½ in. of mercury may be employed. It is self-priming; can run for long periods 'on snore; and it is claimed practically no maintenance is required. The taper roller bearings, in order to retain the lubricant and to exclude foreign matter, are fully protected by lip seals, and the rubber-to-metal contact of the two moving parts (screw rotor and plate wheel) insures minimum wear.

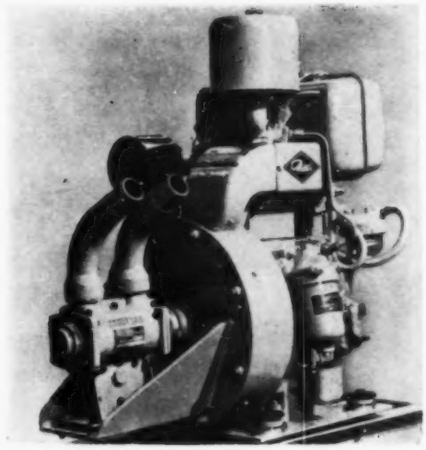
Since 1955 The Telegraph Construction and Maintenance Co. Ltd. (Telcon) has supplied nearly 200 miles of 11.5-kv plastic transmission cable for laying in Lake Maracaibo by Shell and other companies. This is a polythene insulated cable designed by Telcon with screened cores, PVC-sheathed, armored with galvanized steel wires and with each wire separately covered with PVC. A barrier against the teredo is provided by a tinned-copper screen over the insulated conductor. The dielectric is unaffected by water, is nonhygroscopic, and affords protection from corrosion.

Ruston & Hornsby Ltd. has uprated its engine range. Two medium-speed diesels have been pressure-charged, and are now known as class 'VCBX' engines. Available in 5- and 6-cylinder sizes, these 5- and 6-VCBX engines have a bore of 8 in. and stroke of 10¾ in., providing a power range of 255 to 330 bhp (BS rating) at 600 to 650 rpm. The 'VCB' engine range extends from 102 to 330 bhp in six engine sizes of the same cylinder dimensions, with a wide measure of component interchangeability.

Sumo Pumps Ltd., member firm of Stone-Platt Industries, announces its submersible pumps are now fitted with the company's new Clam-Seal motors. Originally developed for use in Texas to resist sand in bore-hole water, these motors are prefilled with oil and completely sealed. Sand damage and trouble from hard and aggressive waters are overcome.

Leyland Motors Ltd. has received a contract valued at over £250,000 from National Iranian Oil Co. for 60 "Super Hippo" 6-wheeled road tankers. These have a gross weight each of 24 tons, and will be powered by the Leyland 0.680 diesel engine developing 150 bhp at 2,000 rpm. This is a repeat of the previous order from NIOC, now completed.

With production of "STELVETITE" on a small scale about a year ago by John Summers & Co. Ltd., a leading UK steel manufacturer, a new construction material of great potentiality was made available—a strip-mill cold-reduced steel sheet permanently bonded on one side with a PVC plastic, with the reverse side either a bonderized steel or an electrozinc-coated surface. Few anticipated the wide range of applications to be developed in a year, and demonstrated by the companies participating in a recent exhibition in London organized by John Summers. Apart from many domestic and architectural applications, among the industrial uses noted were drums (Rheem Lysacht Ltd.), fume ducting (Ductwork Ltd.), and tanks (Electro-Chemical Engineering Co. Ltd.). Because of its high corrosion resistance, BX Plastics Ltd.'s "Velbex" is used for industrial applications, or "Cobex-Velbex" laminate where extra high resistance is required.



New Goodyear A/7 high-speed pump coupled to Petter PC1 air-cooled diesel engine.

V. R. Prehn has been appointed deputy managing director of Ruston & Hornsby Ltd., of Lincoln, England. Mr. Prehn has been connected with the oil-engine industry since he joined the company in 1937.

H. G. Nelson, M. Inst. C.E., M. I. Mech. E., M. I.E.E, managing director of the English Electric Co. Ltd., has been appointed deputy chairman of D. Napier & Son Ltd., and of various other subsidiaries.

Sir Henry Spurrier, chairman and managing director of Leyland Motors Ltd., has been appointed to succeed the late Sir Jackson Millar as chairman of Albion Motors Ltd. Since the war, Sir Henry has been responsible for the impetus behind Leyland's export drive which has placed the company in the lead as the world's largest exporter of heavy-duty commercial vehicles.

New Publications

BP News in Pictures 1958—A selection of some 100 photos and notes typifying British Petroleum group activities last year and emphasizing their worldwide character.

Basic Road Statistics, 1958—A compendium, compiled by the British Road Federation, providing a reference work on road matters in Great Britain and Northern Ireland. Sections cover statistical data on motor vehicles, road traffic and accidents, transport industry, roads, motor taxation, and road-transport legislation. Copies from BRF, 26 Manchester Square, London, W. 1.; Price 1s.

Tanker Freight Rate Charts—Conrad Boe Ltd. A/S, shipbrokers of Oslo, has issued its annual charts of estimated dirty 9,000-18,000-ton tanker freight rates for (a) MOT rates for sterling markets loading Persian Gulf and for Transatlantic voyages, and (b) USMC rates for the bulk of US dollar markets. These charts depict clearly the great changes over the years 1947 to 1958. As new MOT scale rates will soon take effect, a revised edition of the company's "Conversion Tables of Tanker Rates" will be available shortly.

Motor-Gasoline Quality—Under this heading, Shell Petroleum Co. publishes a worldwide survey of antiknock data of gasolines as of December 1958. Amendment sheets will keep the information up-to-date. No less than 180 countries are reported on by areas and, wherever possible, average quality levels for all grades sold are quoted. The data for each grade cover octane ratings (research and motor methods) and tetraethyl-lead content (milliliters per Imperial gallon and cubic centimeters per liter), with additional remarks where warranted. There is also a brief section on the interpretation of this and other gasoline-quality characteristics. Though this publication has been prepared primarily to assist motor manufacturers to determine engine settings for export units or which are made in export areas, it has a wider reference value as reliable and up-to-date information difficult to obtain.

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CANADIAN NOTES

Athabasca Nuclear Test Planned

An underground nuclear explosion tentatively scheduled for next winter in the Athabasca oil sands region of northern Alberta has stirred speculation that the Western Hemisphere will achieve equal footing with the Middle East in availability of crude-oil reserves.

Plans by Richfield Oil Corp. to carry out the nuclear test in order to free vast reserves of oil from the oil sands have attracted favorable attention from both the provincial and dominion governments. The test would be carried out on Richfield holdings which involve about 2,000,000 acres.

The sands are believed to contain about 300 billion barrels of heavy crude (about 7- to 8-deg API) which when heated by a nuclear blast would, in effect, be "refined" in the ground to a light flowing crude.

In pointing out that the balance of crude oil between the Western Memisphere and the Middle East now stands about 75-25% in the latter's favor, some observers state that the Richfield test may change this balance to a 50-50 basis.

Plans for the test also have enhanced considerably the possibility of construction of a major crude line to eastern Canada, according to speculation in oil industry circles.

USA approval of the proposed test is necessary in that the nuclear device to be used in the Richfield project would be provided by the United States.

Canadian Crude Output To Rise 11%

Industry forecasts mostly indicate Canadian crude production of 500,000 b/d to 505,000 b/d average for 1959, an increase of 11% to 12% over estimated 1958 production of 450,000 b/d. Alberta is expected to have its first overall increase in three years, mostly due to improving West Coast export market compared to depressed second half of 1958.

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A new crude unit tower, part of a current $8 million expansion program, is lifted into position at Canadian Oil Companies' refinery at Sarnia, Ont. The 154-ft tower, weighing 75 tons, will help raise the refinery's capacity by more than 60%, to 50,000 b/d of crude from 30,000 b/d.

Pipeline Throughput Increase

South Saskatchewan Pipe Line Co. has put its automatic booster pumping station into full operation, raising throughput capacity to 42,000 b/d from 34,000 b/d in anticipation of increased traffic in medium-gravity crude from southwestern Saskatchewan in 1959. Line runs from Dollard field to Regina.

New B. C. Strike

Important new oil discovery in northeastern British Columbia has been indicated by Triad Oil Co. Ltd. at wildcat five miles west of Milligan Creek outpost well. New strike, Triad Beatton River Wildcat, is in Bluesky formation, shallower than Triassic sand zone productive in Milligan field eight miles southeast.

Virginia Hills To Step Up

Exploratory play to southeast of Virginia Hills oil pool, where development has been slow, may be stepped up by indicated success of Shell Oil extension wildcat four miles southeast. Virginia Hills pool is 35 miles southwest of Swan Hills field in northwestern Alberta. Shell has large exploration reservation taken out in 1954, well protected for acreage.

Saskatchewan Proration

Application for proration of Saskatchewan medium-gravity crude production was scheduled for hearing, February 11. Conflict of interests involved both producers and pipeline companies handling different types of medium crudes with divergent marketing arrangements and problems. Massive resistance was expected.

Urge Gas-Export Halt

Alberta Conservation Board has been urged by Canadian Western Natural Gas Co. to halt export of gas by Trans-Canada, Westcoast Transmission, and Alberta & Southern Gas until it has been assured future gas needs of the province can be met.

Takes Over Fabricating Plant

Maloney-Crawford Tank & Service Co. Ltd. will assume operation of the tank and steel fabricating facilities of Edmonton Steel Fabricators Ltd. Premier Steel Mills Ltd., which will continue to operate the sucker-rod plant, the tool-and-die shop, and the machine shop, is expanding these facilities to manufacture additional items of supply for the oil industry, including the first nut and bolt manufacturing facilities in Alberta.

Alberta Export Hearings

Oil-industry sources predict Alberta Oil & Gas Conservation Board hearings will result in speedy approval of revised applications for oil and gas export from Alberta.

Alberta Gas Deliveries

Alberta Gas Trunk Line Co.'s December 1958 throughput averaged 240 million cubic feet per day, largest since start of operations in October 1957. Largest proportionate delivery was to Trans-Canada Pipe Lines.

Alberta Plant Produces

An Alberta gas field in which work started more than 10 years ago became a producer only recently when the Cessford gas-processing plant went on-stream. Owners of the plant, located about 100 miles east of Calgary, are Hudson's Bay Oil and Gas Co. Ltd. and Canadian Delhi Oil Ltd. Natural gas from the Cessford multiple-zone field, now supplying eastern Canada, was locked in until the Trans-Canada Pipe Line provided a market—and the incentive for building the gas-processing plant, whose initial operating capacity is 125 mmcf per day. It features a refrigeration type of system designed to condition for sale the sweet, relatively dry gas.

New Pan-Am B.C. Acreage

Pan American Petroleum Corp. filed application with the British Columbia government for 12,500,000 acres in northwest British Columbia. Located to the northeast of Prince Rupert in the Stikine River basin of British Columbia, the acreage brings to nearly 16 million the total held and under application by the company in B.C. The application would increase by approximately one-third the total acreage in that province under lease and reservation or permit.

PERSONALS

ALVAN C. HARROP has been appointed a director of Imperial Oil Ltd., Toronto. Formerly manager of Imperial's employee-relations department, Mr. Harrop has also had wide experience in oil refining operations in Canada and South America.

E. C. HURD has been appointed vice president of Trans-Mountain Oil Pipe Line Co. and its subsidiaries, Vancouver, B.C. Previously he had been administration manager, having joined the company in 1953 as manager of oil movements.

CLARENCE D. SHEPARD of Ottawa has been appointed general counsel of the British American Oil Co., effective January 1, 1959, with headquarters in Toronto.

A. E. ASHURST has been appointed personal assistant to W. M. V. Ash, president, Shell Oil Co. of Canada Ltd. Mr. Ashurst joined Shell in 1950 at Calgary. Early in 1958, he was transferred to the head office in Toronto to assume the then newly-created position of exploration and production assistant to the president.

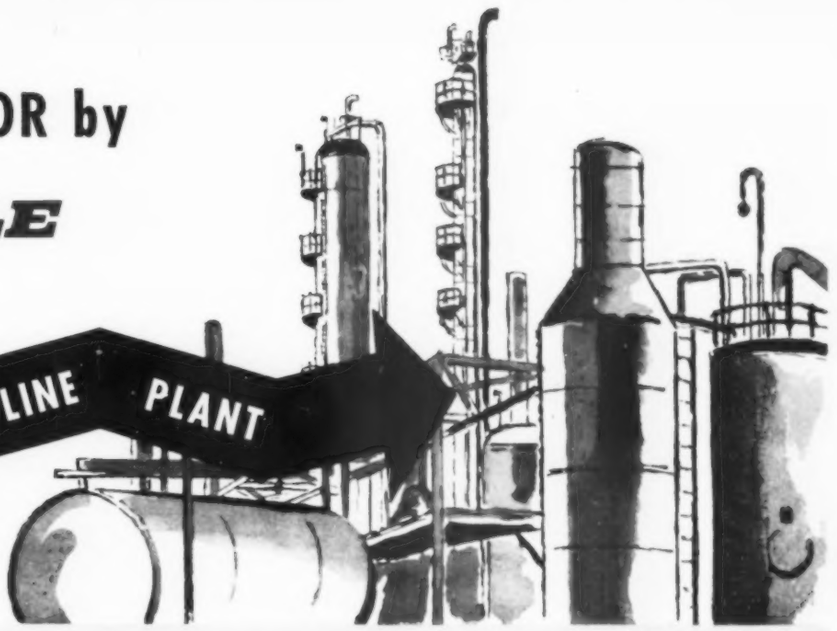
D. R. PRIOR has been appointed manager of the public-relations department, Shell Oil Co. of Canada, a new position. He was formerly assistant to the president, in which post he was responsible for the direction of Shell's public-relations department as well as functioning as a personal assistant to Mr. Ash.

D. R. Prior

A. E. Ashurst

35 TON DEHYDRATOR by AVONDALE

DESTINATION: A GASOLINE PLANT



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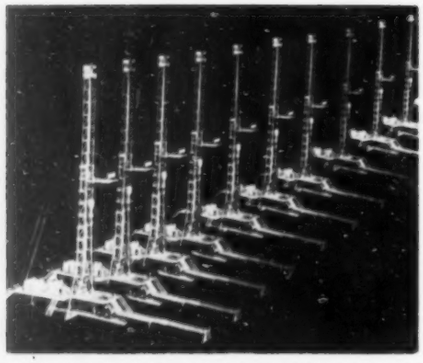
LATIN AMERICAN OIL NEWS



If the 30 Ideco Dual Rambler Rigs for YPF of Argentina were lined up side by side, the line of actual rigs would stretch for more than half a mile.

Identical Rigs For Argentina

Delivery began recently from Italy on the largest number of identical drilling rigs ever known to be purchased in a single order. Twenty Ideco H-40 Dual-Rambler rigs of 7,500-ft nominal capacity are being mass-produced in Florence, Italy, by Nuovo-Pignone, one of five European manufacturers licensed by Dresser AG, to build Ideco drilling equipment. The 20 rigs, which will be shipped to YPF in Argentina over a period of months, are exact duplicates of 10 other Ideco Dual-Ramblers built for YPF at Beaumont, Texas, in 1957, the first group of dual-trailer-mounted rigs in Argentina's Comodoro Rivadavia area. George W. Walton, president of Ideco said: "With these 30 rigs, Argentina will have the largest concentration of identical rigs operating anywhere in the world."

YPF executive E. L. Dalton (center) inspects the modern facilities of Nuovo-Pignone, Florence, Italy, where 20 identical Ideco rigs are being built for Argentina. Accompanying him are Vittorio Scherillo, (left) general manager of the Italian plant, and George W. Walton, president of Ideco Inc., one of the Dresser Industries.

Transferred To Venezuela

Alan H. Brown, who has been on special assignment for the past year with Tretolite Co., division of Petrolite Corp. at the company's plant and main offices in St. Louis, has been assigned to eastern Venezuela as field engineer with South American Petrolite Corp.

Bolivia Geophysical Socy.

On December 1, 1958, in Cochabamba, Bolivia, there was a meeting of geological and geophysical employees of oil companies and associated service companies for the purpose of formulating a local professional group to be known as the "Geophysical Society of Cochabamba." The following were elected officers: Paul D. Balbin, Chaco Petroleum, SA, president; Roger Heggblom, Gulf Oil, vice president; Joseph Keszelik, Seismograph Service Corp. of Bolivia, secretary-treasurer.

The new organization plans to affiliate with the Socy. of Exploration Geophysicists in the USA, and with the European Assn. of Exploration Geophysicists.

Offshore Mexican Discovery

Discovery of the first offshore oil field in Mexico has been announced by Edwin W. Pauley, president of Pauley Petroleum Inc., Los Angeles. The first offshore well was a single completion and tested 422 b/d. The second well was a dual completion, and has been placed in production. Both upper and lower zones tested at 500 b/d of 30 API oil. The wells were drilled from an offshore drilling barge by the Ocean Drilling & Exploration Co., New Orleans, La.

Bolivian Option

Atlantic Refining Co. has taken a one-year option on the 80% interest in 1,250,000 acres held by Bolivia Petroleum Corp., wholly owned subsidiary of Drilling & Exploration Co.

Argentina Curbs Off

President Frondizi of Argentina has abolished all import curbs, and ordered a single free peso rate as of January 1.

Mexican Projects

PEMEX, the Mexican government's oil monopoly, plans $80 million oil expansion projects during 1959.

Additional Peruvian Acreage

Cia. Petrolera del Pacifico (Douglas Oil Co. of California et al. 40%) acquired drilling concessions on an additional 91,000 acres offshore northwest Peru. Acreage is next to the 26,000 acres Douglas assigned in 1958 to Peruvian Pacific Petroleum Co., Cities Service subsidiary. Richfield Oil Corp. has a 50% interest in the Peruvian Pacific operation.

New PEMEX Director

Pascual Gutierrez Roldan has been named as director of the government-owned PEMEX by the new president of Mexico, Adolfo Lopez Mateos. Significant policy changes are not foreseen.

Largest Rig Order To Argentina

Argentina has begun receiving from Italy the largest number of identical drilling rigs ever known to be purchased in a single order. Twenty Ideco H-40 Dual-Rambler rigs of 7,500-ft nominal capacity. They come from Nuovo-Pignone, Florence, Italy, one of five European manufacturers licensed by Dresser AG to build Ideco drilling equipment.

Completion of the current order will bring the total number of Ideco rigs operating in Argentina to 76.

Argentina Spud

First of 50 wells to be drilled by Pan American Oil Co. this year is also first to be spudded under Argentina's policy to permit USA companies to develop production on contract basis. The well is at Cerro Dragon, an area proved 50 miles west of Comodoro Rivadavia.

Brazil Private Investment

Brazil's government has announced it cannot provide $45 million initially required to develop Bolivian "treaty acreage," but Brazil's Development Bank has approved five Brazilian groups to share in the venture along with foreign participation. The bank recommends that latter be limited to 33 1/3% if foreign financing is to be repaid in oil.

Starts Argentine Drilling

Drilling has been started on La Ventana structure, Mendoza province in Argentina, by Kerr-McGee Oil Idustries Inc.; 50 development wells will be drilled for Carl M. Loeb, Rhoades & Co. group. Signal Oil & Gas of Louisiana is participant in $100 million venture.

Gives Up In Colombia

Paria Operations group (Continental, Texaco, Ohio Oil, Cities Service, Richfield) is second to surrender acreage on Colombian border which it was obligated to take in 1957 along with its new Gulf of Paria concessions.

Brazilian Reserves

Government of Brazil spokesman says proved crude reserves are 480 million barrels, and crude production exceeds 60,000 b/d.

Ecuador Sale By Santiago

Santiago Petroleum Corp. has sold to Tennessee Gas Transmission Co. 1,530,000 acres of petroleum concessions and producing properties in Ecuador. The sale by Santiago included all of the Ecuadorian concessions and related properties of Manabi Exploration Co. Inc. and Pacific Exploration Co. Inc., both of which are wholly owned subsidiaries of Santiago. Cash payment was approximately $1,700,000 and an obligation on the part of Tennessee to expend not less than $870,000 during the next two years.

Santiago, which is a 100% subsidiary of Pan-Israel Oil Co. Inc. and Israel-Mediterranean Petroleum Inc., has retained a 3% gross overriding royalty interest in all production found on presently nonproducing concessions, with provisions for this to increase to 4% when production reaches 10,000 b/d. In addition, Santiago has the right to re-acquire any portions of the concessions on Tennessee's relinquishment, with all government rentals and work obligations fully met and in good standing a year in advance.

New Haiti Test

First wildcat on Haiti's mainland in 10 years has been spudded to test the Miocene to a depth of 7,000 ft. Last exploratory drilling was by Atlantic Refining in 1944-47.

Union Oil In Argentina

Union Oil of California has obtained an exclusive 27-year exploratory and development concession over two parcels totaling four million acres in the Comodoro Rivadavia basin of Argentina.

French In Cuba

Three French firms won a $2.2 million contract to build a gas plant and gas-distribution network at Marianoa, near Havana, Cuba. Contract was concluded by Cia. de Servicios Metropolitanos de Gas which had secured support of Cuban Bank of Industrial Development.

Trinidad Refinery Expansion

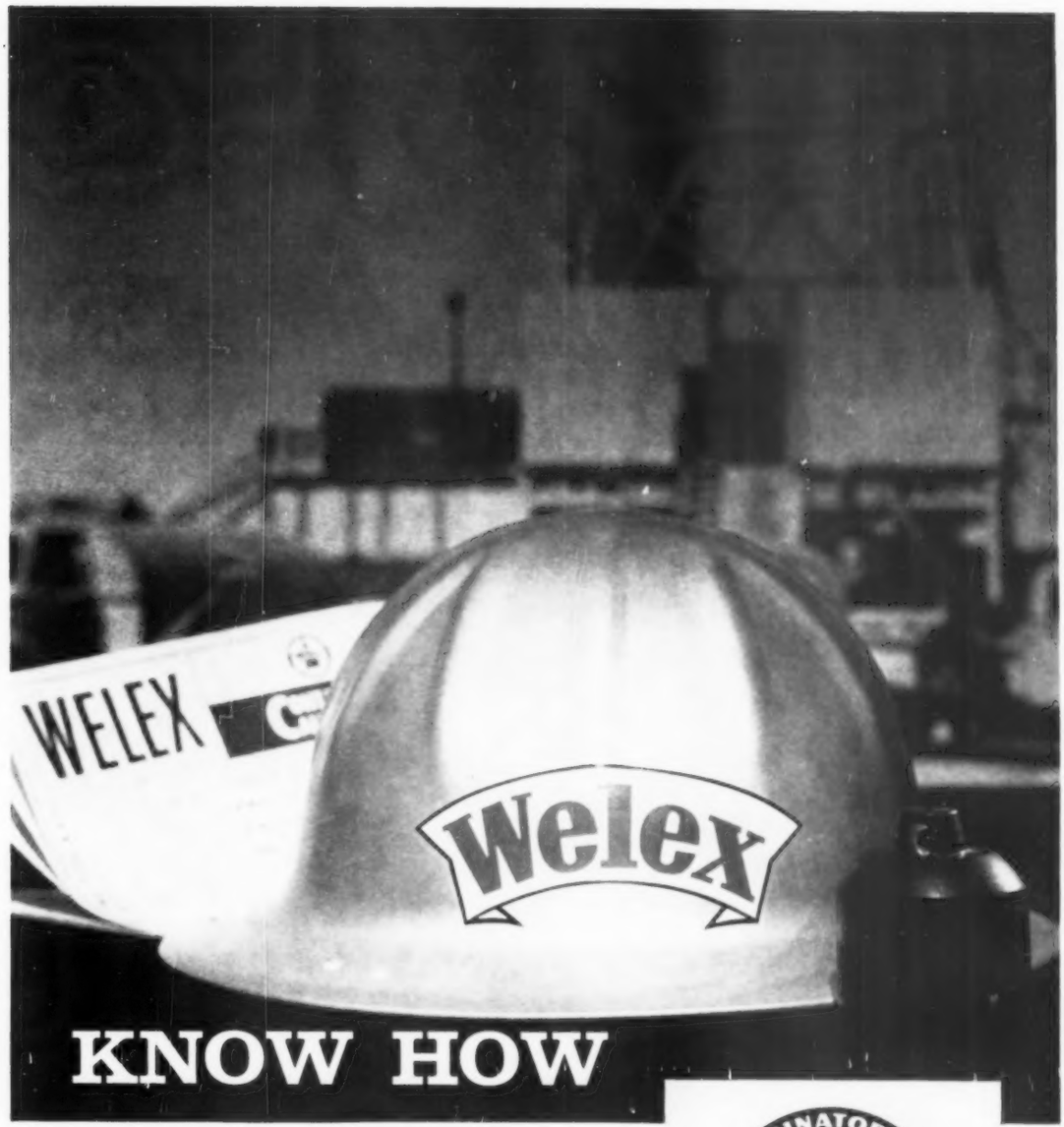
A $20 million expansion program is planned to double the capacity of Texaco's 125,000 b/d refinery at Pointe-à-Pierre. Plant's capacity has been increased to the present level from 75,000 b/d in the two years since Texaco bought Trinidad Oil Co., and oil production has been stepped up to 50,000 b/d from 30,000 b/d—with substantial increase in reserves.

Venezuela Expands Refining

A 60,000 b/d expansion program now under way will bring capacity at Gulf's Puerto La Cruz refinery in Venezuela to 115,000 b/d. Texaco holds a one-third interest in the plant, and Gulf's Mene Grand Oil Co. two-thirds.

First Trinidad Bonuses

First bonus for new oil rights will be paid by a Socal subsidiary under agreement announced by Chief Minister Eric Williams. Trinidad for past year has been considering new oil law, patterned after Venezuela's, which would make bonuses mandatory, but none has as yet been drafted in final form. Mr. Williams and Dominion Oil Co. agreed to pay $5,600 for rights on 1,581 acres in south and east of island, plus $3.50 per acre for other lands up to 11,000 acres. Drilling will be started within three months after award of leases.



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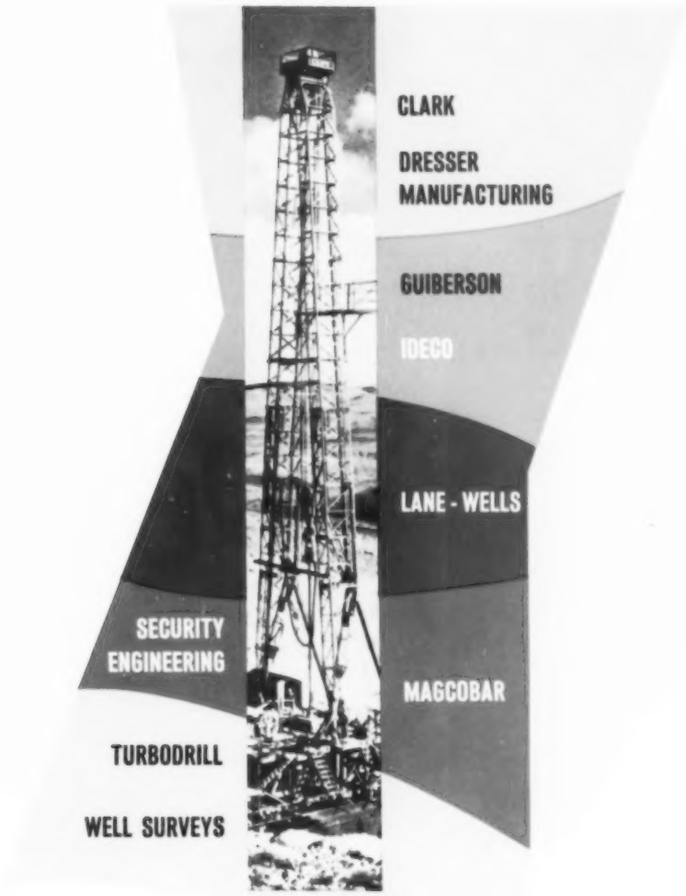

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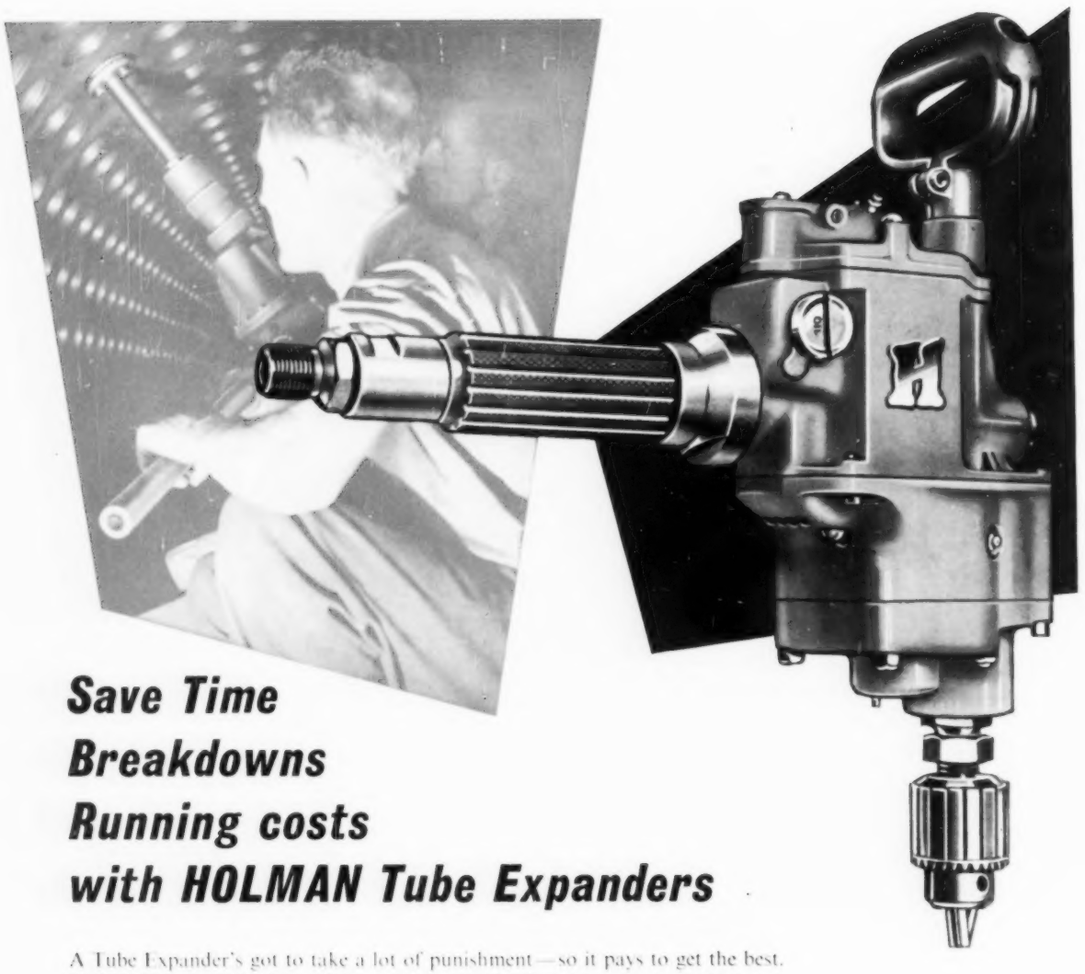

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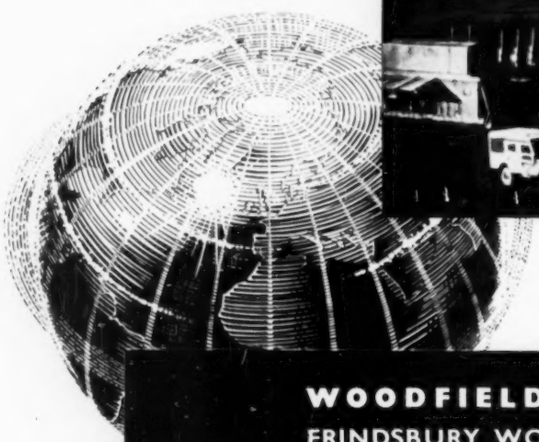

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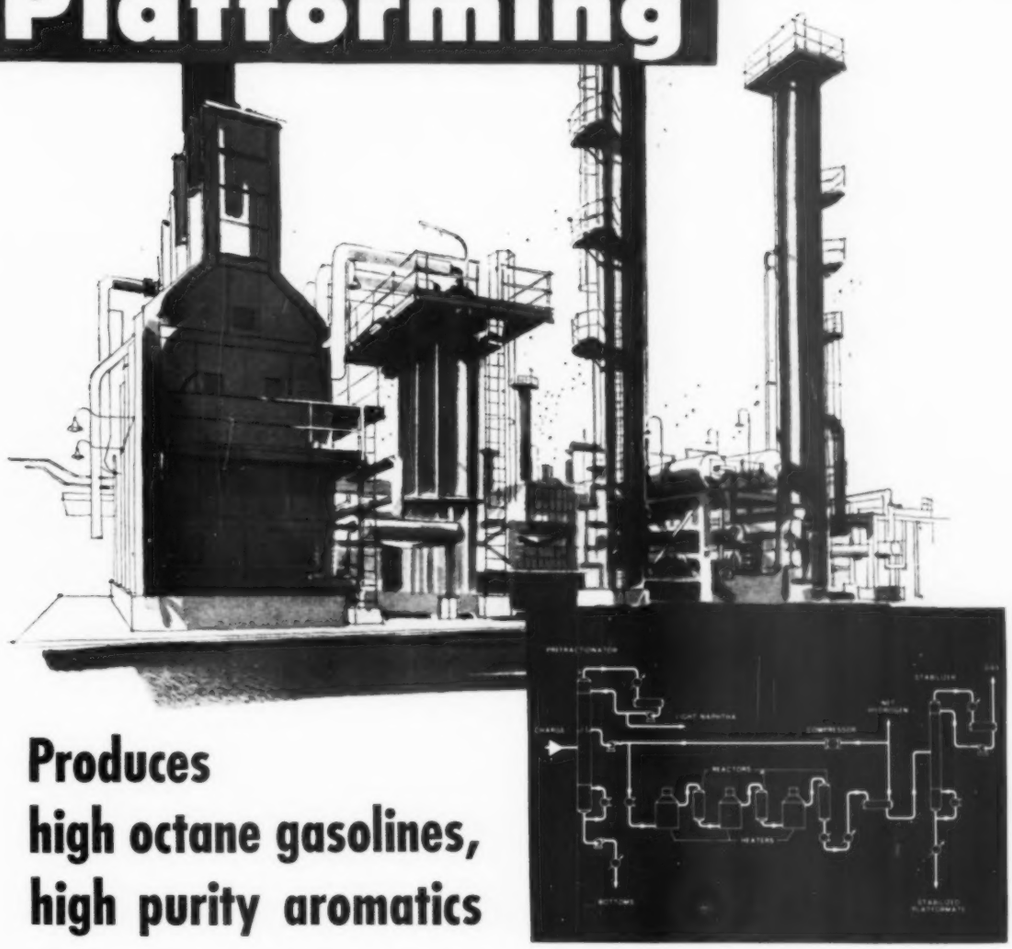

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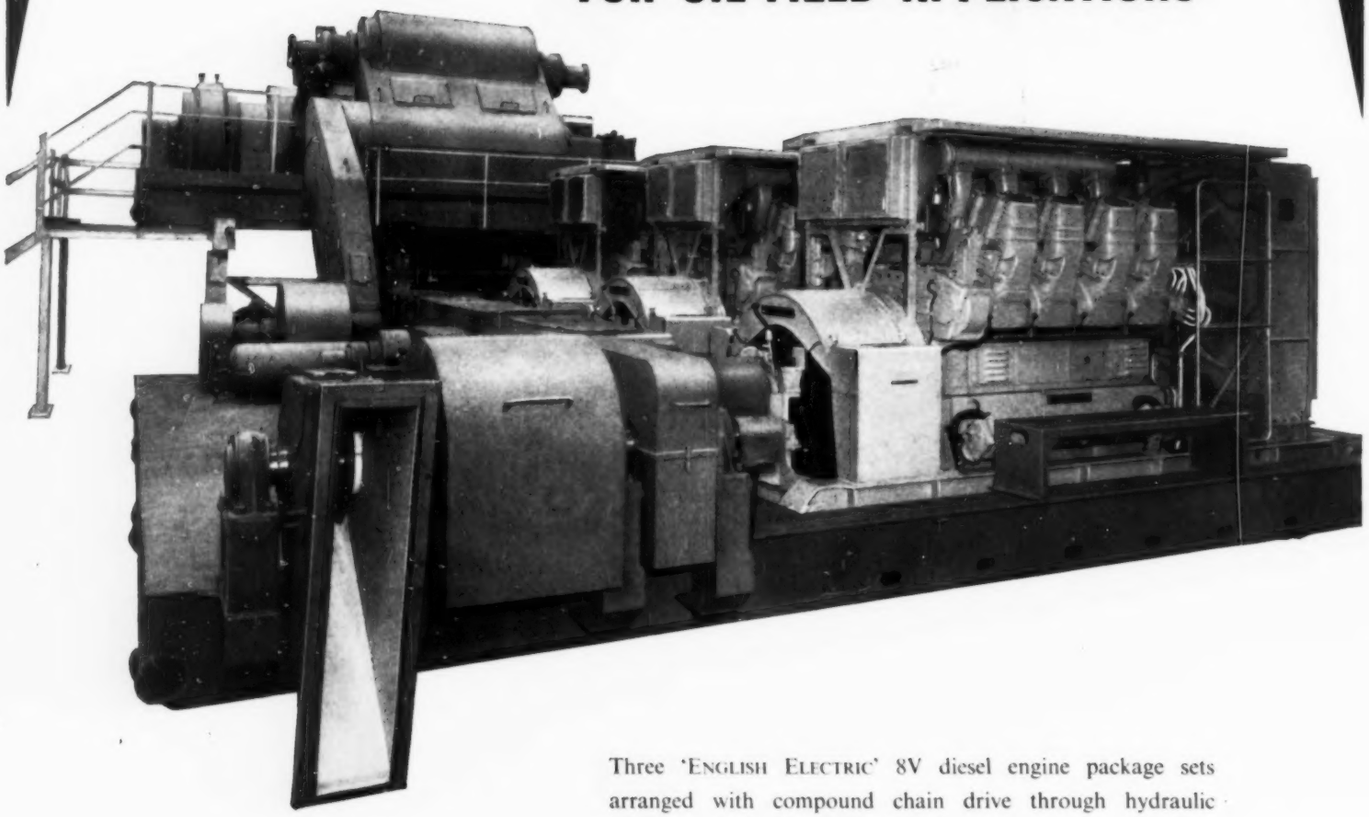

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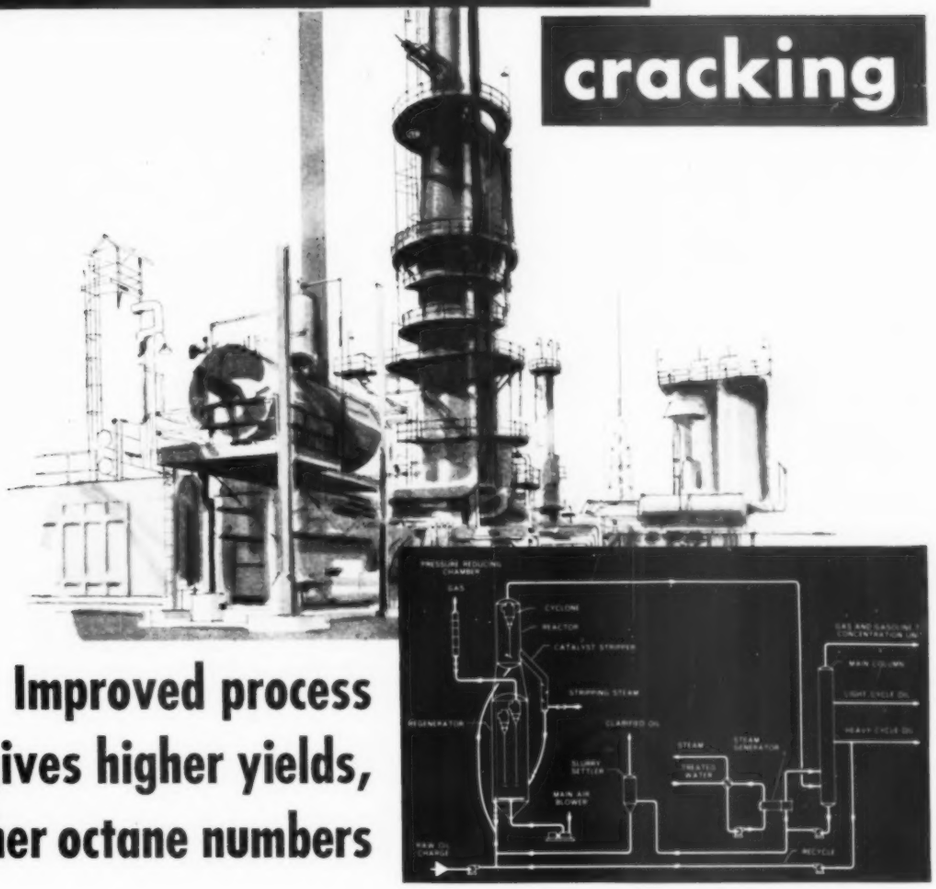

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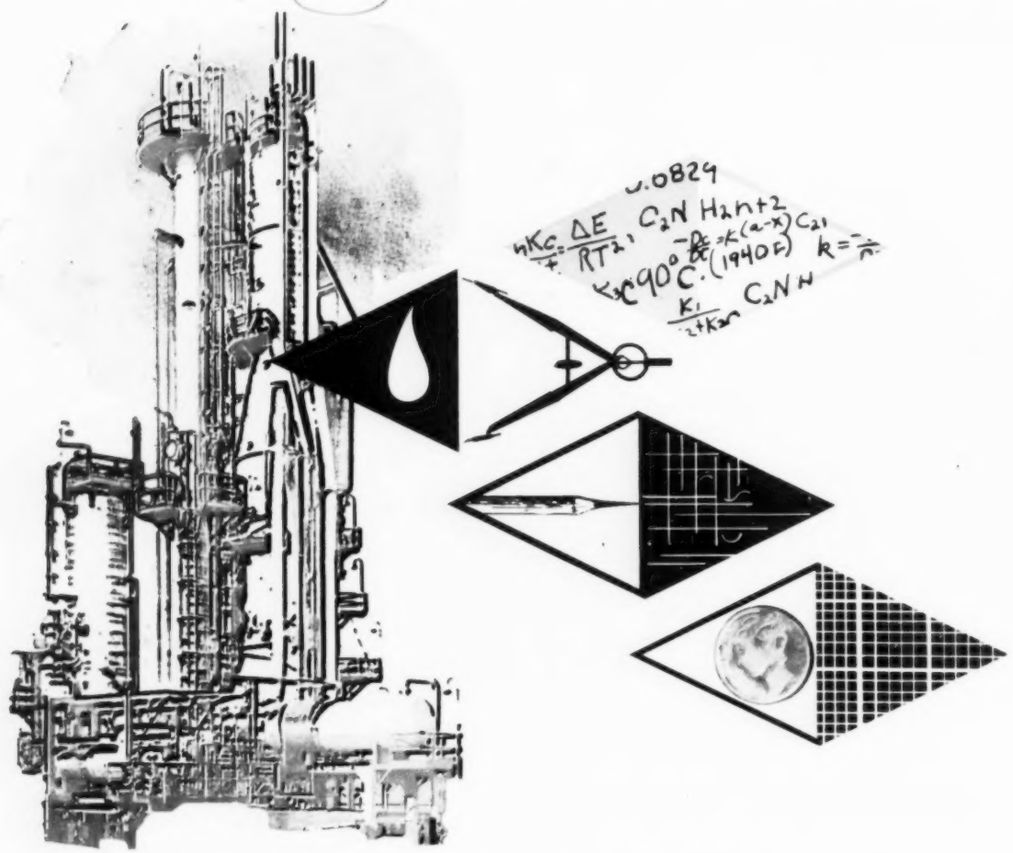

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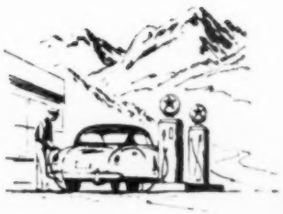

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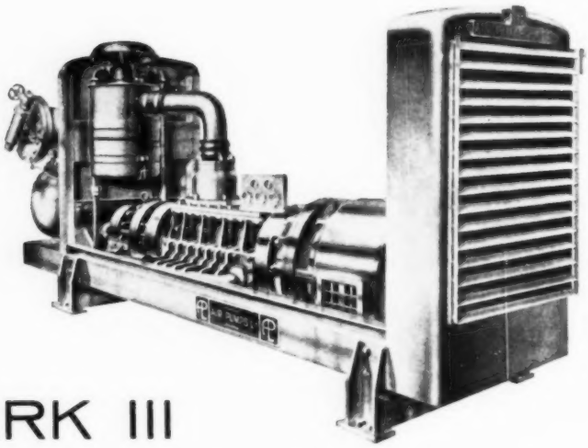

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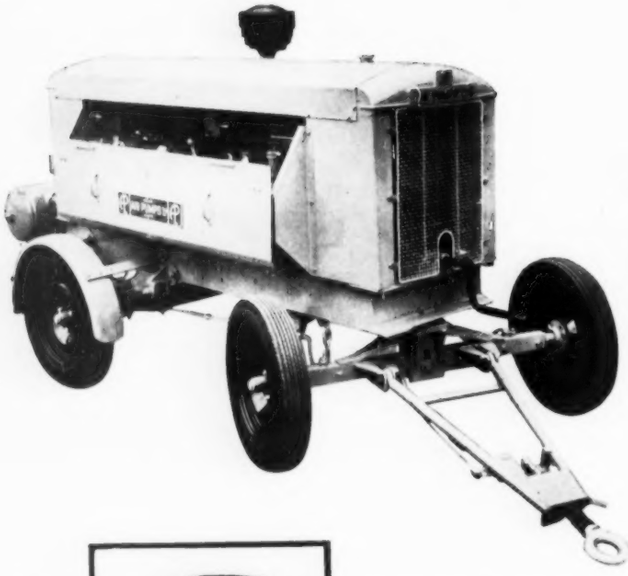

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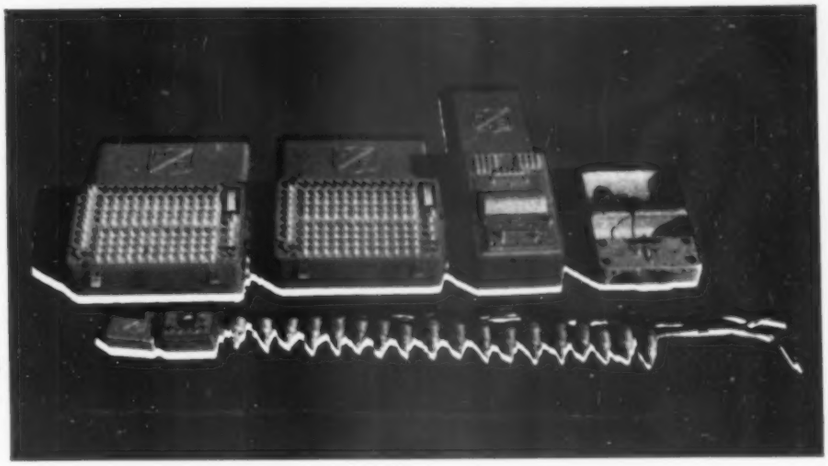

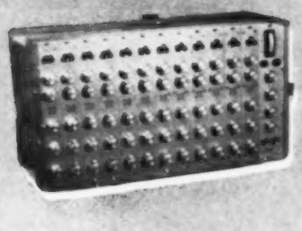

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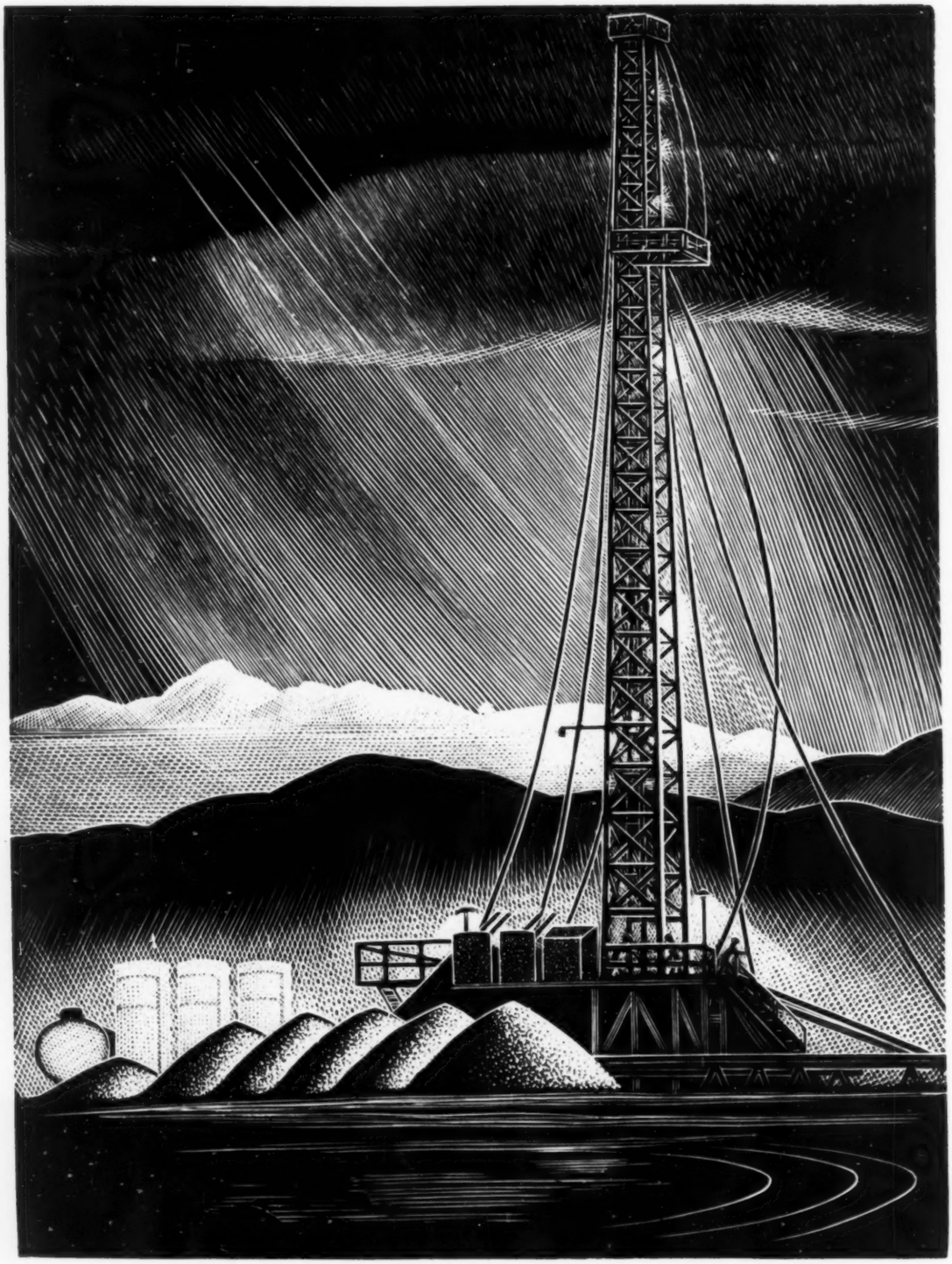

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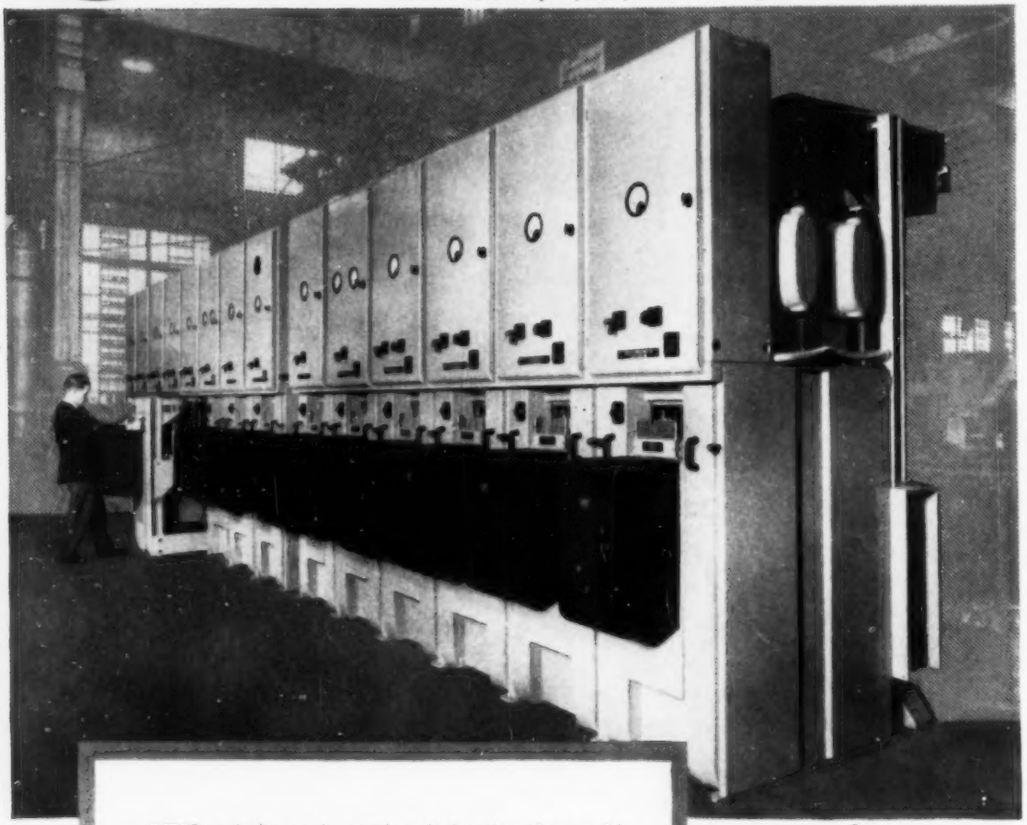

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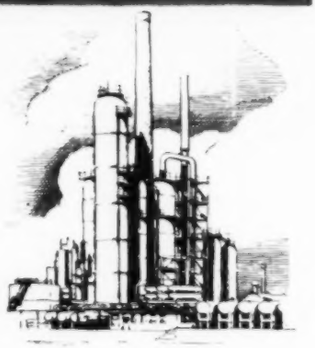

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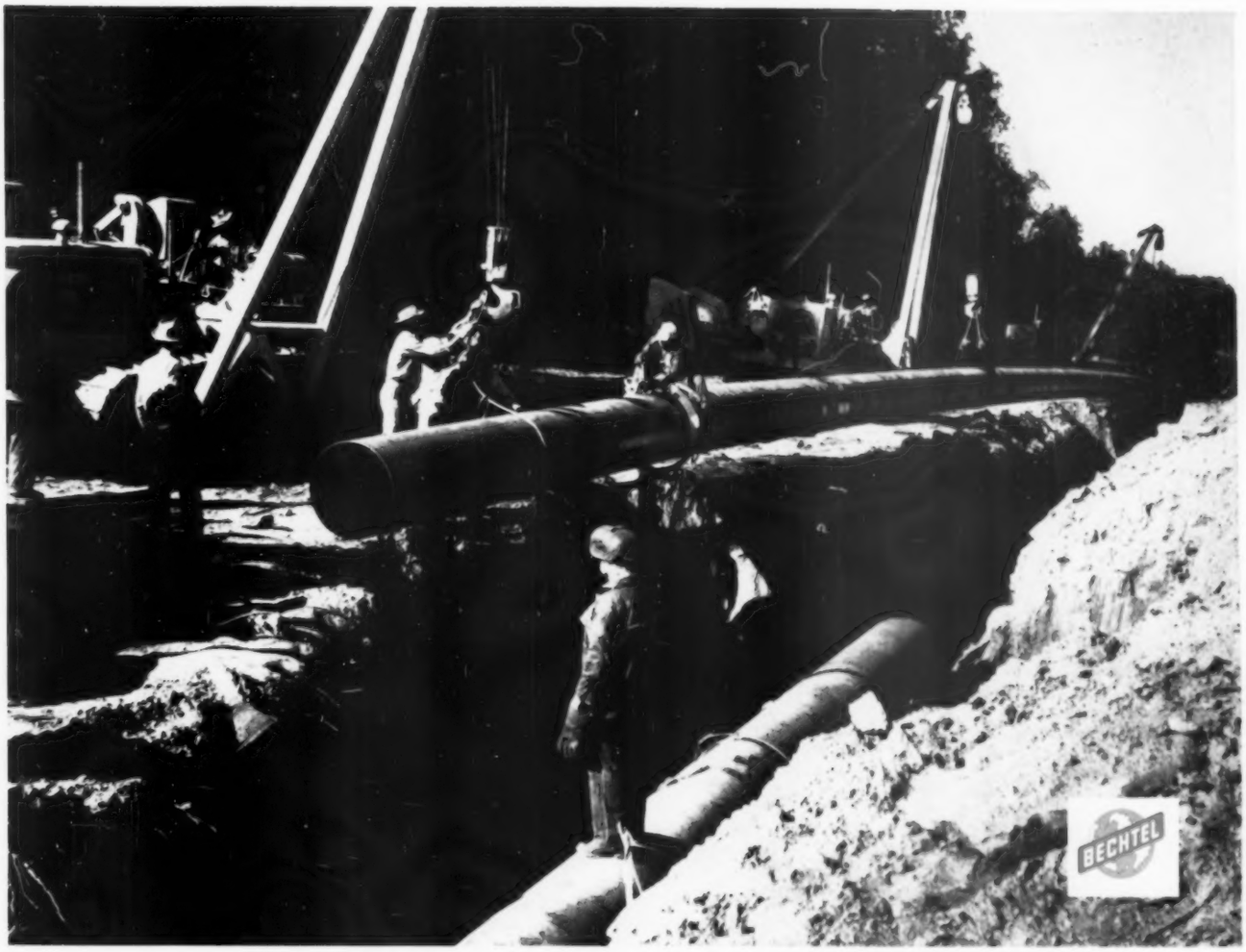

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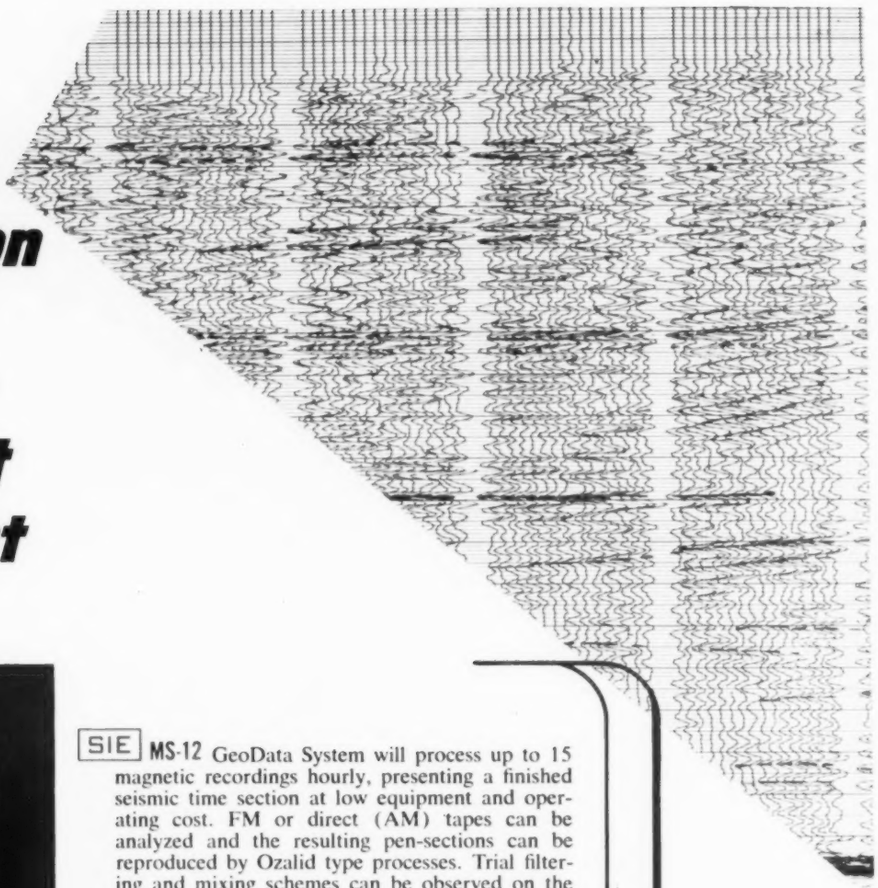

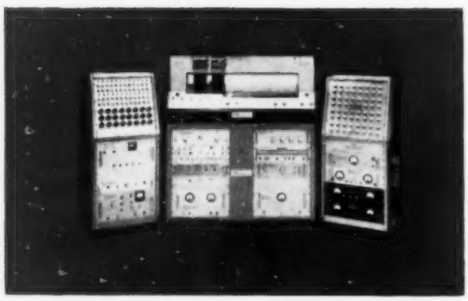

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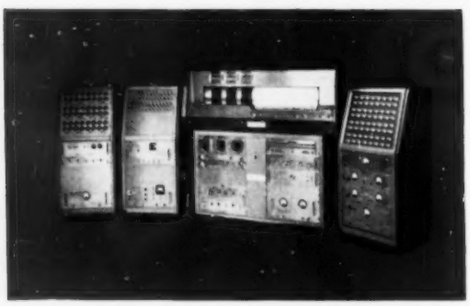

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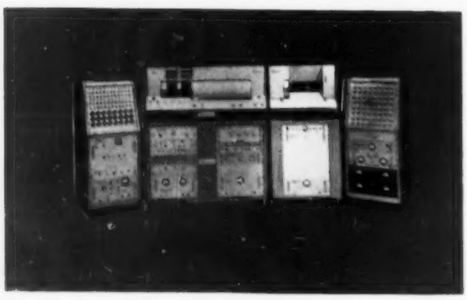

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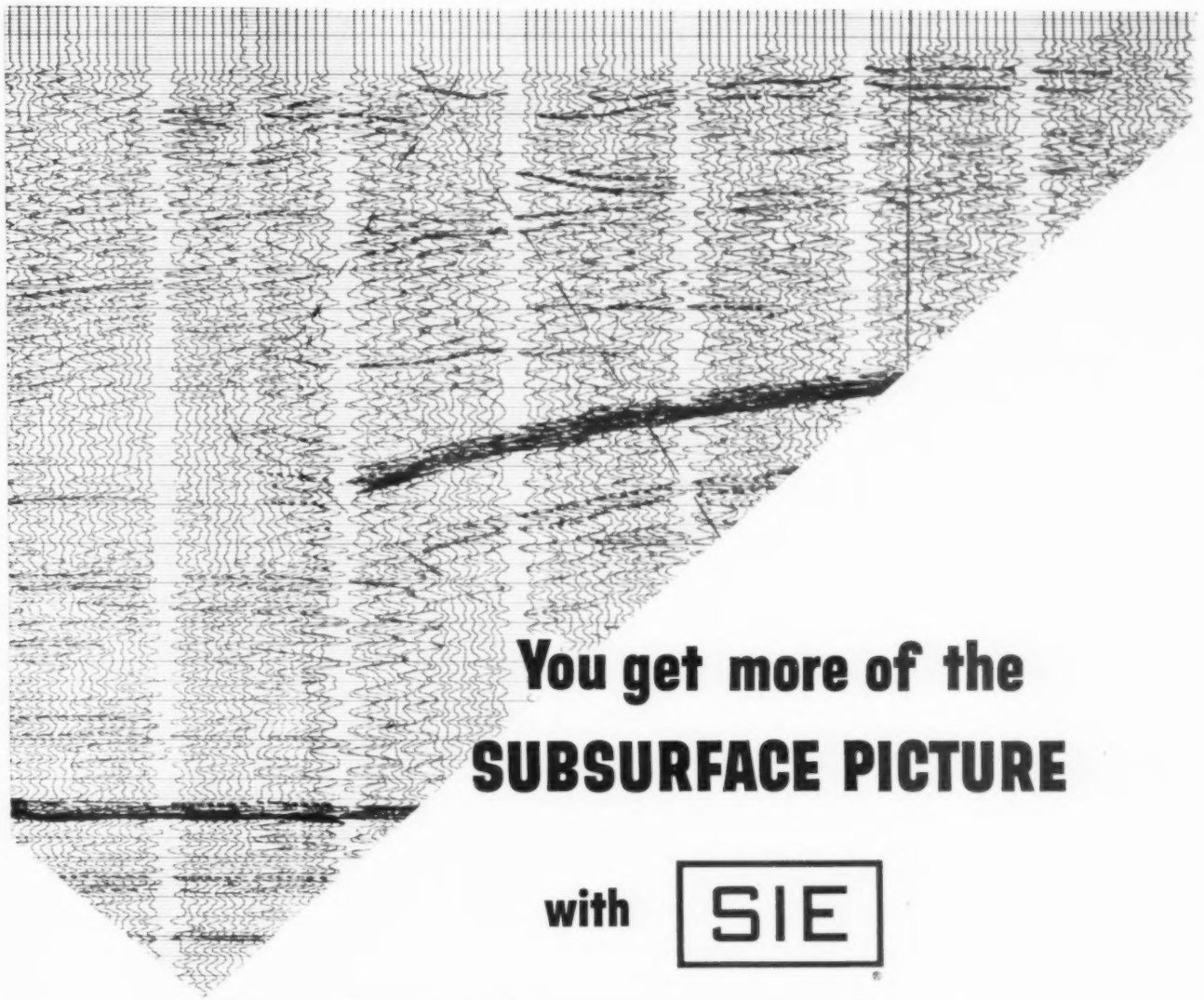

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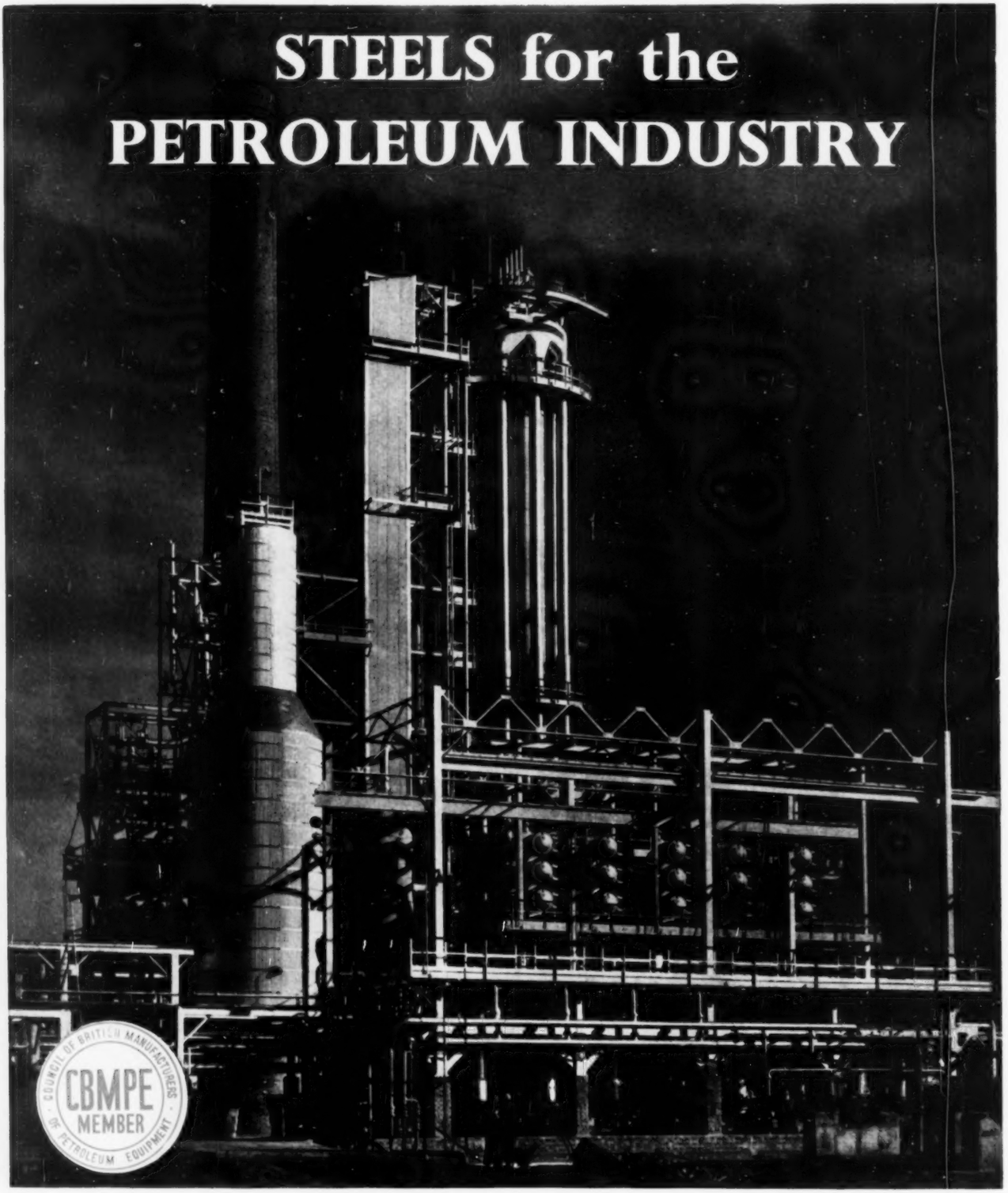

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International Trade Stimulation

The Congress of the United States has before it for consideration a bill designed to stimulate investment abroad by offering tax incentives. H.R. 5, introduced by Hale Boggs of Louisiana, known as the "Foreign Investment Incentive Tax Act," extends and amplifies the tax incentives now granted to domestic concerns which trade elsewhere in the Western Hemisphere.

The proposed act is in line with the thinking of President Eisenhower whose message to Congress on foreign economic policy said: "The whole Free World needs capital, and America is its largest source. In that light, the flow of capital from our country must be stimulated and in such a manner that it results in investment largely by individuals and private enterprises rather than by government."

One of the President's specific proposals, which stemmed from his conviction that the flow of capital abroad "must be stimulated," has been for legislation which would provide for a 14-point tax allowance. This means reducing USA taxes on corporation income from foreign sources to 38%, where on domestic income the rate is of course 52%.

The Hale bill also would add other incentives, such as postponement of taxes on foreign income until it actually is received in the USA. At present, foreign subsidiaries must be set up if this end is to be achieved.

Some countries have adopted special tax incentives to encourage investment of foreign capital. Under the present laws, these incentives are not effective because the USA government, in effect, absorbs them through taxation. Foreign subsidiaries cannot freely reorganize under present laws without severe tax penalties, and this is another inequity sought to be removed by Congressman Hale.

It is, of course, essential that domestic corporations which go abroad be not penalized by special tax provisions. One such penalty which has been proposed is the elimination of the depletion allowance on foreign oil exploration. The depletion allowance has been a favorite whipping boy in Congress for many years, but thus far has stood the test of time because of its fairness to the producer who daily assumes high risks in the search for new oil. Foreign operating and exploration costs are high for many reasons, and final net profits are usually modest. Elimination of the depletion allowance would have the immediate effect of retarding the foreign investment program which the President favors.

In a recent address before the Harvard Business School Club, T. S. Petersen, president of Standard Oil Co., of California, pointed out that stimulation of foreign investment places a responsibility on the government desiring the capital as well as on the USA.

In addition to tax waivers to adjust for high risks, Mr. Petersen said: "It is essential that they provide means for the repatriation of capital and profits without undue penalties in the form of currency restrictions; and they should provide safeguards assuring that control of the management will remain in the hands of the investors.

"An obvious incentive to investment, too, is a demonstrably high standard of business ethics. Those countries which scrupulously adhere to their agreements with foreign investors, whether written out or tacitly understood, are most likely to attract the capital they need. Conversely, an investor once burned by a country which fails to live up to its part of a bargain, will probably seek other climes."

Freer international trade was suggested by the speaker as a powerful force in stimulating foreign investment. He praised the Reciprocal Trade Agreements Act as a step in the right direction, and the establishment of the European Common Market which should help to deflate the arguments of those who have been reluctant to see the United States lead the way toward freer world trade.

Any student of international trade is aware of the ill will which is often created in the business community when restrictions interfere with the normal flow of goods and raw materials. The present quotas which tend to retard the flow of Canadian crude oil into the United States is a prime example. The import restrictions in theory are to promote national defense, but on that ground cannot be defended as applying to Canadian oil which is unmenaced by any possible foreign invader. USA import restrictions are an irritant to most Canadians today, who blame the severe proration enforced in western Canada more on their neighbors to the south than to the competition of Eastern Hemisphere crude. In the United Kingdom, the electric equipment industry is disturbed and angry because bids on large USA jobs have been rejected and awards made at much higher prices to domestic manufacturers.

International trade is, indeed, a thorny subject. It will remain an area of controversy in the future as it has in the past, but the business community can contribute to the best interests of all free peoples by using its influence in favor of the removal of many restrictions at international boundaries, and for the promotion of activities which will raise the standard of living in the less well developed areas of the world as the oil industry has done in the Middle East, Latin America, and elsewhere through its $10 billion in foreign investment. In taking such action, industry will have to recognize that freer world trade cannot be accomplished in a world of protective barriers designed to shelter against all competition. Areas of compromise must be found.

Geophysical exploration—problems in Libya

by Frederick L. Schenck

DURING 1958, geophysical work in Libya, in approximately 80 concessions held by 12 oil companies, was performed by 11 geophysical contracting companies and four oil-company crews. Libya, a united kingdom covering 680,000 square miles, is on the Mediterranean coast of Africa, south of Italy and Greece. During World War II, much of Libya was the scene of the campaigns of Montgomery's Eighth Army and Rommel's Afrika Korps. Vestiges of former battles are still to be seen, and war-lain mine fields are hazards to surface transport. This is especially true in the areas around Tobruk and Agheila. In ancient times, the coastal areas were sites of Greek, Roman, and Carthaginian civilizations, and even in the more remote interior are found traces of human activities which have not been fully studied. This country presents many problems to the geophysicist.

The coastal area of Libya is serviced by a paved highway which runs from the Tunisian to the Egyptian borders. The coastal area supports the bulk of the population, and is generally low-lying, lightly vegetated, and endowed with sufficient rainfall to support moderate agricultural activities. Coastal Libya has a mild climate without undue extremes in heat or cold. Ground water in populated areas is relatively abundant. Although there are excellent grasslands and oases, there are neither forests nor continuously flowing rivers.

About 30 miles from the coast, the vegetation thins out, and the vast expanse of the Sahara extends to the south for many barren miles, except for occasional oases where water may be found. Some of these inland oases are large in area and support considerable population. Four types of terrain are found: flat gravel plains, sand-covered areas, eroded limestone or lava country, and "jebel" or hill country. Frequently, the sand-covered areas are smooth, flat tablelands with few dunes, but heavy dunes comparable to the Rub'al Khali and sand-mountain country of Saudi Arabia are found in the southeast and southwest of Libya. On the southern border lie the Tibesti mountains, and there are several other areas of extrusives in Libya. But the major areas of the country are limestone plateaux of Miocene, Eocene, and Cretaceous age.

Away from the coastal mine fields, surface travel is generally unrestricted, except in areas of complex sand dunes and in the deeply gullied and heavily bouldered mesa country. The supply routes into the interior always are long and tedious dirt tracks, and over these large quantities of operational and technical supplies must be trucked. These hauls to the more remote regions frequently require a week one way, and thus it develops that the logistical problem is the major difficulty to be solved in Libyan geophysical operations.

Cargo requirements for truck haulage for a normal geophysical crew average from 20 to 25 tons a week. This consists mostly of nonperishable foodstuffs, water, gasoline, diesel fuel, explosives, drilling bits, survey stakes, and repair-shop supplies. Other more urgent logistic needs are satisfied by aircraft. The Douglas DC-3 is generally used, and the average minimum requirement for a remote camp is one plane load, or about two tons, a week. The aircraft cargo is usually perishable foodstuffs, emergency automotive spare parts, and medical and technical supplies.

The aircraft flights are also used to rotate personnel going to and from rest leaves. The normal work schedule is four weeks work in the field camp and one week off in town. The majority of the geophysical camps in Libya operate on a continuous basis, not shutting down for days off, with enough extra personnel to provide relief for those leaving camp for rest leave or illness. The expensive aircraft space is utilized to its fullest, and weight limitations strain severely the ability of the supply point to satisfy field requirements. Frequently, it is a major decision to determine which cargo and which passengers should be put on the plane and which omitted to best serve the continued field-camp operation. Special aircraft flights are arranged for serious personal and medical emergencies. The camps have radio contact with contractors' base points and oil-company offices in Tripoli and in Benghazi.

The usual field camp consists of 15 to 20 expatriate technicians and 50 to 100 skilled workers, semiskilled workers, and laborers. Tents are the usual field-camp housing, although most camps are equipped with air-conditioned office and dining trailers, kitchen trailer, shop trailer, and shower trailer. Some of the camps in Libya have sleeping trailers. All are equipped with electric generators and gasoline- and water-mounted, but sometimes skid-mounted. For storage tanks. These are usually trailer- economy and efficiency, a field camp should be organized and equipped so it can be packed up and moved in less than a day's time on its own automotive equipment without undue loss of productive technical effort. Smooth field-camp operation is not an easy task, and an experienced camp manager is required to look after the necessary domestic details without distracting the

FREDERIC L. SCHENCK holds a degree in mining geology, with high honors, from the Missouri School of Mines. He was elected to the engineering honor societies of Tau Beta Pi and Phi Kappa Phi. He has been employed in geophysical capacities by The Atlantic Refining Co., in Texas, and by the Arabian American Oil Co., in Saudi Arabia. He left Aramco in 1955 to become manager in Venezuela for Robert H. Ray Co. He is now manager for Ray in Libya. He has also worked for Oil Properties Consultants, in Pasadena, Calif., as petroleum geologist. He was an officer in the U.S. Army during the war, and saw service in the Pacific and European Theatres.

The present article was compiled with the able assistance of Kenneth Poland, Libyan manager for McCollum; Fred E. Stapleton, Ray seismic supervisor; and Glen I. Conger, Ray gravity supervisor.

Shifting sands in the Libyan desert.

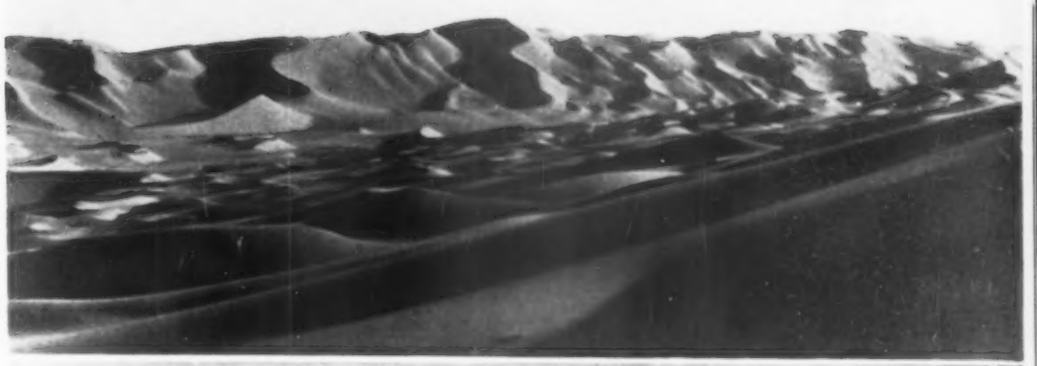
party chief and other crew members from technical matters.

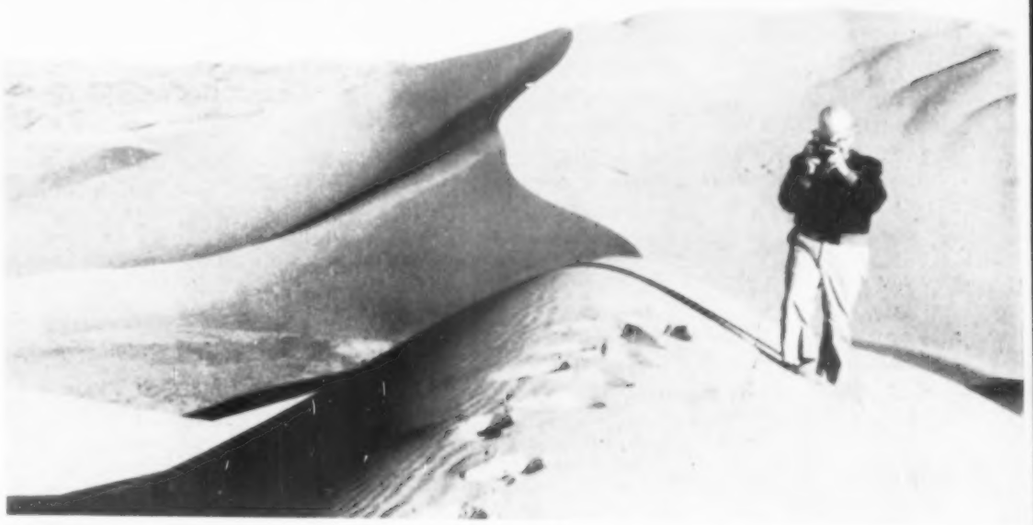
Automotive Problems: The major automotive equipment for geophysical operations in Libya is usually eight-ton gasoline or diesel trucks with 14 x 20 or 16 x 20 sand tires, power steering, long-range fuel tanks, winch, and 4 x 4, 4 x 6, or 6 x 6 drive. Larger and heavier vehicles are desirable for desert operations, but these are not at present provided by geophysical contractors because of the pressure of competitive pricing and the budgets of the oil companies. The smaller vehicles are usually $^3/_4$-ton 4 x 4 trucks with 11 x 16 or 16 x 16 sand tires, long-range fuel tanks, front winch, six-bladed fan, oversized radiator, electric fuel pump, and oil cooking system. Smaller vehicles, in the opinion of many, are not adequate for continued rough service in desert geophysical operations.

To support field operations, at the town end of the supply line must be a warehouse extensively stocked with spare and replacement vehicle parts. The supply point must have facilities for local and foreign purchasing and for receiving, storing, and shipping supplies to field camps.

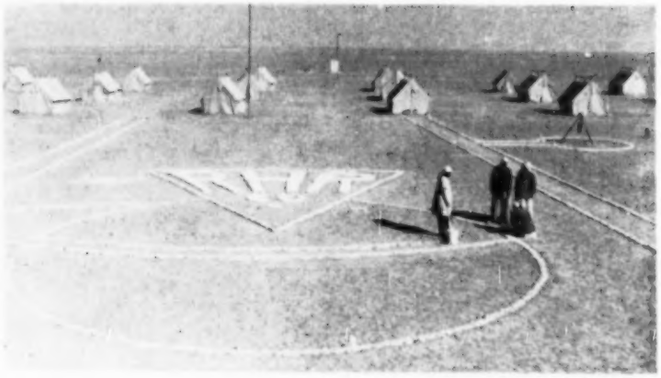
Automotive spare parts in the quantities required are usually not available locally. Although this situation is slowly improving, local automotive dealers do not have inventories and repair facilities sufficient for the requirements of the petroleum industry in Libya. Practically all automotive spare parts are brought in and stored in their own warehouses by the geophysical and oil companies for reserve supply and for replenishment of field-camp stocks. Inventory levels must be high at all times, for usually four to six months elapse between placement of foreign orders and ship delivery of automotive parts. A great deal of mechanical experience in desert field-camp operations is required before stock requirements of spare parts can be accurately assessed and held to reasonable levels, at the same time having at hand required items to prevent expensive shutdowns. Despite this, emergency items frequently have to be air-freighted from the United States or Europe to Libya.

Usually it is not advisable to attempt vehicle repairing in town. It is far more economic to keep an adequate supply of parts which can be air-shipped to the field camp when required. When a vehicle breaks down in geophysical operations in Libya, it is usually many hundreds of miles out in the desert, and it is not practicable to try to get such a vehicle to town. For this reason, despite the somewhat unsuitable field-camp conditions, vehicle repairs, even major repairs, should be done in the field camps. In the desert, conditions of dust and sand are such that, despite the most painstaking precautions, motor failures are abnormally frequent. A good supply of short-block assemblies must be maintained in order that engine changes can be made





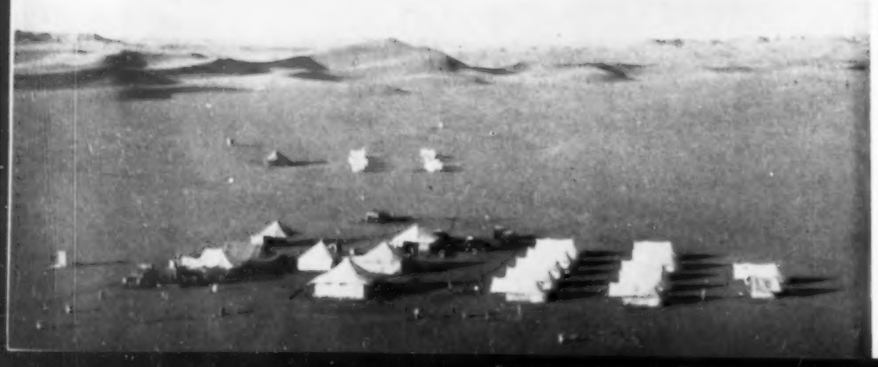
Sand tires are given a tryout astride a sand dune.



Dressing up the camp with rock patterns for the Robert H. Ray trademark and walkways.

Not all of the Libyan desert is sand. This terrain is also tough on motor vehicles and tires.

Seismograph party camp in Libya.



quickly when incipient engine failures are detected. This prevents loss of production time, and the old engine can be repaired at leisure and held ready for replacing another engine.

The field-camp mechanics have to be resourceful individuals, able to resort to ingenious expedients to keep their equipment in good operation despite the severe handicaps of desert work. Often the vital part required is a little item costing about 50 cents, which is in abundant supply—on the other side of the Atlantic Ocean. Much of the mechanics' time is spent in searching for lost or broken-down vehicles. This is minimized, and much time and money are thereby saved, by imposing and enforcing a strict driver discipline for travel only on definite, prescribed routes. Two senior mechanics and a number of skilled assistants are required for a desert field camp.

Mine Clearance: In the coastal sections of Libya war-laid mine fields are still dangerous to personnel and equipment. Although it is asumed by some that only a fourth of the remaining mines are dangerous, it is impossible to tell, with the mine still in the ground, whether it is dangerous or not. Such objects are always dangerous. Despite extensive and expensive precautions, several people recently were killed or injured by mines, and considerable equipment damaged. Existing military mine-field maps are incomplete, and many of the hazards are of the casual type—such as a few mines laid out in passes where canalized enemy vehicles would find their progress impeded.

When geophysical operations commence in a suspect area, cleared lanes are marked for routes of travel and for the geophysical lines. A mine field, when encountered, is not completely cleared; only a roadway wide enough for the vehicles or for the geophysical operation in progress is cleared. This is marked usually by whitewashed piles of rock at close intervals or by special concrete markers. Two mine detectors operating side by side, each swung across a two-meter arc by a slowly walking man, are sufficient for a vehicle road. When a wider lane is required, more mine detectors and operators are used. The mine-clearance foreman follows directly behind the sweepers, ready to probe and to investigate suspicious metallic objects located by the detector. The cleared lane is marked by a team following directly behind the foreman. The vehicle of the mine clearance unit follows to the rear. The mine-clearance unit foreman is required to drive the vehicle over his own cleared lane at the end of the day's work. Mine-clearance foremen are required to have had actual military experience, usually in combat, as sappers. Progress of a mine-clearance team is slow, and ranges from a few hundred meters to about 18 kilometers a day, depending upon the number of metallic objects encountered. Areas which have been subjected to heavy artillery fire cause very slow progress because of the numerous metallic fragments. When mines are found, they are either exploded in place by small charges placed on top of them, or pulled out by a long cable attached to the vehicle. Normally, there are about 10 men on the mine-clearance team. The sweepers are relieved frequently, for theirs is tiring work. Mine clearance places severe restrictions on seismograph recording techniques because it limits the area and shape of multiple shot-hole and multiple geophone layouts.

Surveying: Libya is rapidly becoming a well mapped country as a result of geological, geophysical, and photogeological surveys. Before the advent of oil companies, accurate maps of the interior of the country did not exist. Prominent towns and other locations in the interior have been found to be as much as 20 kilometers misplaced on the wartime maps. Vertical control is equally scant, and is not reliable. At present aerial mapping of a large number of concessions has been completed, and accurate maps are available for the first time. Level lines have been run from the coastal areas into the interior. One second-order level line was run by Robert H. Ray Geophysics from Tripoli into the southern Fezzan. The total closure distance was about 3,000 kilometers, and the closure error was 2.30 meters over this distance. Markers from this line now form the base points for other elevation surveys in western Libya. This work was done during the summer of 1956, when heat waves and refraction were acute and when the field work could be carried on only during the early morning and late afternoons.

Horizontal control is gained by first- and second-order astronomic fixes of prominent points within the concession areas. These astro fixes, especially the first-order ones, are accurate to a hundredth of a second in both latitude and longitude, and are the bases for horizontal control of the aerial maps and for the geophysical surveys. These astro fixes are normally tied into existing level lines for horizontal control.

Semipermanent markers are usually set up at line crossings of geophysical surveys. Individual geophysical station locations are usually marked by wooden stakes with colored plastic flagging. These items are attractive to the local Bedouin population, the first being used for camp fires and the latter for brightly-colored decoration in the hair of Bedouin women. The problem of the destruction of survey markers is not peculiar to Libya.

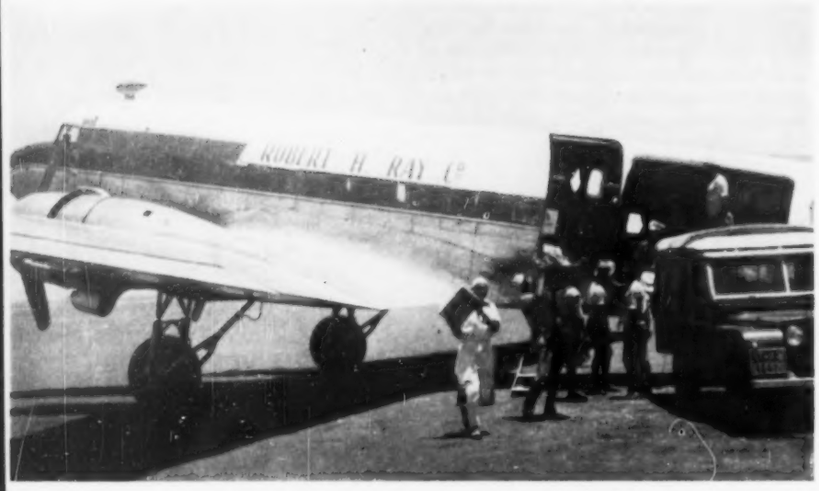
Gravity and Magnetometer Surveys: The agreement between the gravity maxima and geologic structure is well established in Libya, with local exceptions in two generalized areas where it is believed the gravity minima are important keys in structural and tectonic interpretation. The great bulk of concession areas in Libya has already been covered by gravity surveys which, in general, are used for location of areas of interest to be worked by more definitive geophysical methods in the first go-around of petroleum exploration.

Gravity surveys in Libya have been conducted by vehicular parties and by parties equipped with helicopters. The latter cannot compete costwise with parties equipped with vehicles, regardless of the type of terrain. However, the helicopter offers considerable time advantage in extremely rugged terrain or in heavily mined areas. Use of helicopters in remote areas greatly increases the burdensome logistical problem. Depending upon conditions of terrain, a land gravity party will run from 650 to 1,800 gravity stations per month, with an average production figure of about 1,200. As may be imagined, considering the foregoing comments on mine-clearance problems, gravity production in heavily mined coastal areas is limited entirely by the progress of mine-clearance units. In this respect, the Tobruk and Agheila areas were notably difficult. In such areas, all of the expense of mine clearing should not be charged to gravity operations because the trails cleared form safe routes to be used from then on by other exploration methods.

Residual gravity maps and second derivative maps are showing their value in Libya. As elsewhere in the world, the gravity surveys in Libya have proved a powerful initial tool for concentrating the search for petroleum to the most favorable areas. The size of gravity loops in Libya vary with the anticipated structural conditions and the programs and practices of the oil companies. Loops have ranged from a 10-kilometer square to a 3 x 5-kilometer rectangle. The smaller loops seem more desirable because of closer control and the possibility of missing small geological structure. Since a gravity survey progresses rapidly, the larger loops are generally deemed inadvisable because of structural density considerations and the difficulty and expense in recovering survey markers upon returning to an area to gain closer gravity detail.

The normal gravity crew in Libya consists of four surveying teams, two meter teams, and an office computational staff—all of these with extra personnel for relief during rest leaves. The ground magnetometer is best run in conjunction with a gravity survey because only one additional vehicular unit is required to impose the magnetic work upon the gravity-survey grid. Some of the concession areas in Libya have been covered by ground magnetometers; others by aerial magnetometers. These surveys have added valuable data for structural interpretation and geophysical results.

Seismograph Surveys: In 1958, 17 seismograph crews were active in petroleum exploration in Libya, and these crews produced about 25,000 kilometers of reflection and refraction profile for the 12 oil companies holding concessions in the country. With very few exceptions, these crews operated from camps in the distant desert interior. In almost all cases, the oil companies are utilizing the most modern seismic instruments and equipment for recording signals on magnetic tape or disk for later playback on office systems. Robert H. Ray Geophysics is operating an office playback system in its installation in Tripoli, Libya, and two of the oil companies have their own



All supplies for field reconnaissance parties are brought in by plane or helicopter.

Joseph P. Saiato, mine clearance supervisor for Oasis Oil Co. checking area for mines after helicopter landing during gravity survey in Libya.

record processing units in Libya. These produce statically and dynamically corrected wiggle sections and variable-density profiles which aid materially in the interpretation of reflection seismograph results.

Most areas in Libya are difficult record areas, and the spread layouts for reflection work usually involve multiple-shot patterns and multiple-geophone layouts. Seismograph-reflection work on the Miocene, Eocene, and Cretaceous outcrops is hampered considerably by difficult drilling and poor record conditions. The limestones range from soft and chalky to hard with chert nodules.

Most reflection crews utilizing conventional methods require four to six combination air-water drilling rigs, and in the limestone areas consumption of rock bits and explosives is high. The normal reflection-seismograph problems in Libya are identical to those encountered in the Edwards plateau area of West Texas. To overcome a poor signal-to-noise ratio, multiple holes and multiple geophone layouts are almost exclusively employed. Shot-point patterns range upward to 60 holes from one to six meters in depth. Weathering shots are usually recorded at desirable intervals. Geophone arrangements frequently utilize from 24 to 48 phones, or more, per trace for a 24-trace seismic system. Ground overlap of 50% to 100% is in common use.

As in all other production seismograph surveys, the shooting and recording techniques used are often compromises in which the number of holes and geophones utilized are balanced against a record of reasonable quality produced at an economical cost. In areas requiring mine clearance, the space limitations for pattern layouts are considerable. Reflection spreads are generally of the split-continuous type and, depending upon the local reflection quality, range in coverage from 400 to 1,200 meters, the average

Oversize tires permit supply trucks to move over loose sand without undue difficulty.

Three ton weight mounted on truck for Geograph or "thumper" survey.

R. H. Ray mine clearance jarmen Turner and Morgan, at left, inspecting German mine belt exposed by shifting sand near Bir Zelten, Libya.

being in the 400- to 600-meter range.

The refraction method has been utilized in a number of cases in Libya to advantage, with a saving in cost. Refraction results in Libya can generally be graded as fair. Difficulties in interpretation are encountered with changing velocities.

One of two basic noise factors present in the limestone outcrop areas during reflection is a high-frequency energy of 50 to 100 cycles per second, apparently traveling in all directions, and usually of one second or longer in duration. The high-frequency noise is most pronounced in the harder drilling areas. The second noise factor is ground roll, normally traveling away from the shot point and frequently diffracted at near-surface discontinuities. The ground-roll frequency ranges from 20 to 30 cycles per second. Wind noise is overcome by placing geophones 4 in. to 6 in. under the surface.

The reflected signals are predominantly 25 to 55 cycles per second. Since maximum cancellation of both noise frequencies cannot be accomplished by geophone and hole patterns, the more prevalent procedure is to utilize shooting techniques to minimize the low-frequency noises, and to filter the records sharply on the high side to eliminate the objectionable high frequencies. In nearly all cases, a poor signal-to-noise ratio exists. A few, fairly persistent reflections are recorded in various areas, but generally maps are constructed from phantom horizons based on the most continuous information and dips within a time range. Well information is too sparse to attempt any long-distance correlation of data at present.

Surface shooting techniques have been utilized by several companies in reconnaissance programs. Shot points are offset laterally 800 to 1,200 meters from the spread, and spread coverages range from 400 to 1,200 meters. This meets with varying success. Surface shooting is feasible only in certain areas, and where fast coverage and low resolution work is satisfactory. Adverse winds cause unfavorable static conditions which are detrimental to safe shooting practices. Both in-line and lateral offset shooting has been used, but the lateral method has proved more successful. A record from surface shooting techniques is low-frequency, with few continuous bands of energy which carry more than three or four kilometers. This method imposes considerable limitations on the time interval in which reflected energy may be recorded.

Attempts to use correlation shooting have not been successful on a wide scale in the past, but experiments with carefully controlled recording techniques and subsequent analysis through office playback facilities have given encouraging results. Near-surface velocities remain fairly constant in large areas, except when sudden outcrop changes occur. Pattern shooting on the sand-covered areas poses critical near-surface velocity problems which are solved either by shooting deep holes for uphole time, or by weathering shots. The selection depends upon the specific requirements of the area. Sand dunes frequently are built over, and obscure, buried hills or mesas; and these, therefore, present a special weathering problem. In the sand areas, drilling is limited to water injection or to conventional mud circulation. The latter is usually not employed due to the length of water hauls and the lack of and expense of hauling equipment. In the extremely difficult sand-dune areas, seismic exploration is limited to random lines between the dunes with only few tie lines, and frequently jump correlation from line to line is necessary.

The majority of the Libyan anticlinal structures which have been investigated so far have low dips which do not require migration of depth points in seismic interpretation. Faulting is common in some areas. Unconformities are believed to exist on a widespread scale, and are evidenced on some of the seismic sections. However, the discordance angle is usually small, and actual truncation is difficult to prove by the seismograph.

At present, very little is known about the velocities in the sedimentary section. Over a dozen deep wells have been drilled in Libya, some with a measure of success. These wells have practically all been surveyed for velocity by conventional or continuous logging methods. The results of these surveys are not generally available. Subsurface velocities determined from the reflection and refraction records indicate widely changing conditions.

The Geograph: One experimental McCollum Geograph, or "thumper," crew has been operating in Libya. The Geograph method has the advantages of lower cost—both through elimination of explosives and drilling, and through less equipment being required. The nature of the low-frequency impulse from the Geograph is advantageous by reason of the absence of high-frequency noise which proves troublesome in some areas of Libya. Some of the technical seismograph problems in Libya are identical with those encountered in the limestone areas of West Texas, where the Geograph method has been employed successfully for several years. At the present time, use of the Geograph in Libya is only starting, and full details of the results are not now available for publication.

In the Geograph method, a nest of geophones is installed at either end of the spread, and the weight truck proceeds from one nest of geophones to the other, dropping the weight at intervals and in patterns which have been determined experimentally to be suitable for obtaining the optimum seismic records in the area. The seismic events from each drop are recorded on magnetic tape, and the data from a number of sequential drops are composited to give one trace on the final seismogram. This is the same as one trace on a conventional seismogram which records the mass impluse received at one geophone-pattern area. The Geograph method is thus essentially equivalent to conventional pattern shooting and pattern recording, with an added great advantage that bothersome high-frequency noise is eliminated. A great future for the Geograph in Libya is predicted. END

Helicopter base at Puri No. 1 well in western Papua, about 220 miles northwest of Port Moresby, New Guinea. Well site is serviced by Sikorsky S-58 helicopters (British Petroleum Co. photo).

World exploration expands in 1959

THERE are a few regions left in the world which oil companies have not entered as yet, but they become progressively fewer as the oil hunt expands agressively from the Spanish Sahara to the Canadian and Alaskan North. As this survey goes to print during early February, a survey by country indicates that 1959 will be a record exploratory year everywhere but in the United States—and there, too, activity is rising. A Soviet scientist has even suggested that oil can be found on the moon! (But no drilling report is expected from there for a long, long time.)

Present drilling and geophysical activity is reviewed here by major continental areas, excluding the United States, Canada, and communist areas. It shows the remarkable expansion of effort in Argentina and North Africa, two areas which may some day join the classic oil exporting triangle—Venezuela, the Middle East, and Indonesia.

AFRICA

The continent is enjoying an unparalleled expansion in exploration activity. In *Somaliland Protectorate*, Standard Vacuum is drilling on Dagah Shabel, a wildcat spudded during late 1958. On February 3, it was at 3,000 ft, with some oil shows.

Somalia: Two wells are drilling, Merca No. 1, by the Conorada-Sinclair group, is now at over 6,000 ft. Dahrin No. 1, being drilled by the Italian government through Mineraria Somalia, a subsidiary of AGIP, is drilling ahead with no shows reported.

Tunisia: Conoraria has two surface crews working, and will begin seismic work soon. The company has no drilling rigs in as yet. SEREPT is drilling two wildcats, one at Bir El Adams, and one at Oued Siah. No results are known.

Algeria: About 38 rigs are running in Algeria at present. In the Hassi Messaoud field alone, some 17 are drilling, none of them for CFP and eight for SN REPAL. Three rigs are busy on the Hassi R'Mel structure, and three in the Zarzaitine field. CREPS company expects to drill about 90 wells in 1959 (it has the Edjélé and the Zarzaitine fields) and will have an impressive total of wells drilled at Edjélé, since a well can be completed in 10 days there. Fifteen seismic crews were running in early February and three gravity parties.

Libya: Standard Oil Co. (Libya) Inc., drilling through its Esso affiliates, has completed 13 wells; and, on February 3, was drilling the 14th. Inazua No. 1 is a deep well; as of February 3, 1959, it was at 7,042 ft, and a heavy rig has been moved in. Slight oil shows have been encountered. Esso's Ed Bdea well was abandoned dry

in early 1959 at 8,888 ft, at the last report.

Gulf Oil of Libya was drilling its third test, Ubari, below 5,000 ft during February 1959. American Overseas, the Caltex affiliate, was below 3,000 ft on its Scelua No. 1 wildcat, about 80 miles south of the Gulf of Sidra.

British Petroleum drilled a deep test, Wadi Zachim No. 1 during 1958.

Oasis Oil Co., operator for Amerada, Continental, and Ohio Oil companies, has three rigs running. It is delineating its discovery made at Bahi, which was followed by another, evidently on the same structure, at Dahra. A third well between the two, Thalith No. 1, was reportedly dry (although this has not been confirmed) at 5,125 ft during early 1959. It encountered some oil shows higher than the objective, however.

Tanganyika: British Petroleum's Mandawa No. 7 well, latest in a series of wildcat wells, was at 11,500 ft at the end of November 1958, and drilling ahead.

Kenya: British Petroleum's Lamu No. 2 well in Kenya was spudded and drilling at over 2,000 ft at the beginning of 1959. No results are reported.

Nigeria: Shell has made a discovery at 10,483 ft at Ekulama well, which counters the disappointing results at Oloibiri. The Ikang well is now drilling in Calabar province. The Miriegbe well in Ogoni division way dry at 10,516 ft, and the rig is now drilling at Ikono east of Aba Town.

Senegal: At last report, Balandine No. 1 well was drilling—with no shows encountered.

Gabon: Nine rigs are working in this area, with active development of the small fields encountered to date pushed.

Portuguese Guinea: No drilling has been started. A marine seismic crew is working, as well as a land-based double-gravity party.

Ivory Coast: A deep test was drilling at year-end 1958 near the coast at Abidjan.

Ghana: No drilling is in progress.

Cabinda: Gulf oil is drilling ahead at Bucomazi No 1, a wildcat now below 4,000 ft.

FAR EAST

Australia: Wapet is drilling two wells—Meda No. 2 and Frome Rocks No. 1.

Papua: The Far East's outstanding recent find, the Puri discovery in Papua, has fallen off in a disappointing manner, but the well stimulated interest in an area where exploring companies were about to pull out after two decades of fruitless effort.

Burma: Burma Oil Ltd. drilled two wildcats: one was dry and the other, Hteinigun, is currently undergoing production tests.

India: Standard Vacuum abandoned Bolpur, last of a series of wildcat wells, at 5,000 ft, and spudded Rhanagat on January 14. As of February 3, 1959, it was at 1,124 ft.

New Zealand: The first well by the Shell-BP-Todd Oil Services, known as Kapuni No. 1, was spudded January 27, 1959, and is currently drilling ahead.

Philippines: Standard Vacuum's Abaca wildcat was abandoned at 7,956 ft. It was not encouraging and, as of February 3, was testing some upper zones. Ipil No. 2 was being prepared during early February.

MIDDLE EAST

Afghanistan: The Swedish drilling crew at Sar-i-pul, which was drilling for the government, has reportedly been removed by the Russians who are now participating in Afghanistan's exploration program.

Abu Dhabi: British Petroleum's Um Shaif No. 1 was completed as a producer at 8,000 ft. BP now has Um Shaif No. 2 drilling below 4,000 ft after a delay with a fishing job.

Bahrain: A deep wildcat on the Buri structure was still drilling on January 27, with no results reported.

Iran: A mobil drilling barge is on its way to Iran for Pan American, and will spud in about July 1959. SIRIP, the joint Italian-Iranian company is to spud its wildcat offshore soon. NIOC has been active with six rigs in operation. Four are drilling in the Qum region—three on the Alborz structure and one on the Saradjeh structure, 30 miles southeast. Another rig is drilling in the Mazandrian plain south of the Caspian. The consortium is operating nine rigs. The consortium's Binak well was at 5,827 ft on November 28.

Iraq: Basrah Petroleum Co. drilled Samawa No. 1, which entered the Zubair at 6,335 ft, and went to 8,114 ft before being abandoned. Nahr Umr No. 3 was cemented at 10,108 ft, and was testing (as of January 15). IPC has four wells drilling: Kirkuk 117, at 7,500 ft at end of November; Kirkuk 123, which was an observation well at 4,500 ft total depth; Pulkhana No. 5 is now running casing at 5,400 ft; Oilibat well was spudded on October 31. No results have been reported.

Israel: The deep test by Pan Israel Oil Co. and Israel-Mediterranean (both of the William F. Buckley group) was abandoned at 7,400 ft in late 1958.

Jordan: Pawley Petroleum's Halhul No. 1 was abandoned at 6,010 ft, and the rig moved to Suweileh No. 1. Phillips Petroleum is operating the venture now.

Kuwait: Minagishi No. 1, a wildcat in southwestern Kuwait, was at 7,000 ft during early February 1959. No shows were reported. A wildcat drilled at Mutriba was dry. A second wildcat at Sabriya during 1958 was a "small producer."

Muscat & Oman: The Ghaba wildcat was at about 10,994 ft on October 26, with no shows reported. Later reports indicated the well has been abandoned.

Cities Service, in Dhofar Province, is drilling GM No. 1 well and MIO No. 1 at about 9,000 ft and 7,000 ft, respectively. Both reported heavy oil shows on the way down, but they were not considered very significant.

Saudi Arabia: The usual total of eight exploration parties worked in the concession area of Aramco during 1958. The company used five rotaries to complete 19 deep wells during 1958, including the Kurais and Manifa discovery wells. Manifa No. 2 was spudded in August, and at the last report was below 7,600 ft. 'Ain Dar No. 56 extended the Ghawar field by about 12 miles to the north. During September, No. 5 well was being drilled in the Khursaniyah field.

Preparations are under way to drill the offshore area of the Kuwait-Saudi Arabia Neutral Zone by the Japan Petroleum Trading Co. An offshore barge is being floated in from the United States.

Syria: The German firm, Concordia, owned by Deutsche Erdoel, has three rigs operating. As of mid-January 1959, Cheikh Sollakh No. 1 was at 3,266.9 meters, Mamichlie No. 1 was at 1,364.5 meters, and El Barde was at 1,724 meters.

The Menhall Co. has been expropriated, and it is not known whether its rigs are operating.

Trucial Coast: Abu Dhabi is covered separately. Elsewhere in this area, Murban No. 2 was drilling below 2,500 ft at the end of 1958. Two seismic parties are working for Petroleum Development (Oman) which is owned by Iraq Petroleum Co., plus one double gravity and magnetic party in the Fuqait area.

Turkey: Twelve drilling rigs are active. Amoseas, a Caltex affiliate, was testing Khata No. 4 as of February 3, 1959, their fourth well in the area since the discovery was made in 1958. Turkish Petroleum Corp. was drilling a deep test in the Kentalan area. Esso Standard (Turkey) Inc. was drilling another test in the vicinity of Gercus No. 1 at the year's end. Mobil Exploration is operating two seismic and one double-gravity party.

SOUTH AMERICA

Venezuela: A total of 82 rigs was running at the beginning of 1959, including both development and exploratory rigs. The total of wells drilled in 1958 was about 1,150, compared with 1,825 wells drilled during 1957. Drilling in 1959 will be probably even lower, since most companies have curtailed their exploration and drilling budgets.

A number of companies are drilling in Lake Maracaibo, where important discoveries have been reported regularly. Among the latest was that of Phillips Petroleum Co., operator for a group of seven companies. The discovery was well LPG 14-4, which flowed at the rate of 7,008 bbl of 35-gravity crude daily.

Argentina: About 70 rigs were operating for YPF at the end of 1958. Pan American had three working on its area, and "El Banco" (C.M. Loeb, Rhoades) also had a rig installed. Two of YPF's rigs were in the Tierra del Fuego area, being operated by Laughlin Bros.

Colombia: Socony's affiliate, Colombian Petroleum Co., had five rigs operating, two of them exploratory and three development. By the end of February, the ratio was expected to be reversed, with three exploratory. They are: Diolo No. 2 and Oru No. 5, both rigging up at the beginning of February; and at the end of February the third well, Loba No. 1, was to have been spudded.

Peru: Texas Petroleum has no rigs running. At Maquia, El Oriente has one rig running in the field, after abandoning its

wildcat south of there at 4,526 ft. Amotape is drilling the first of 20 wells on the coast. Peruvian Parific is drilling offshore, using the "Rincon" barge. International was drilling a deep wildcat in the northern part of the Lobitos concession in September; later news is not available.

Geological crews of Texas Petroleum, Socony, Gulf, Shell, Peruvian Pacific, Cerro del Pasco Petroleum, and El Oriente's German parent companies are operating; and geophysical crews of Geophysical Services Inc. are also in action for several companies.

Brazil: Petrobras is operating about 52 rigs, of which 18 are in Amazonia; 39 geological and geophysical crews are operating. Brantley Drilling Co., Texas, will drill 25 wells in Algoas state during 1959 for Petrobras.

Bolivia: Agua Salada No. 1 was drilling near the end of 1958 on the old McCarthy concession, Los Monos structure. Chaco Petroleum SA is drilling; it is a Tennessee Gas subsidiary operating for a four-company combine.

Bolivian Gulf abandoned its first wildcat, Mandeyapecua No. 1, at 11,623 ft during late 1958; and a second test, Mandeyapecua No. 2, also abandoned—this time at 6,500 ft. A third test to the northeast is now under way.

Paraguay: Pure Oil Co., drilling for a four-company combine, is drilling a wildcat in the southern portion of its concession area. This is the company's third try.

Ecuador: TULM Corp. is to spud a wildcat during June 1959.

CENTRAL AMERICA AND CARIBBEAN

Bahama Islands: Cay Sal 4-1, a deep wildcat by Standard of California and Gulf, was drilling between 16,000 ft and 17,000 ft on February 3, 1959, with no results reported. The well is on a self-contained platform in 30 ft of water. It is the second exploratory well in the Bahamas; the last was in 1955.

Barbados: The only drilling company, Gulf, pulled its rig out and sent it to Bolivia. The last well was Morgan Lewis No. 1. It was abandoned at 15,077 ft.

British Honduras: Phillips Petroleum is to drill an exploratory well on farmout acreage during early 1959.

Costa Rica: No drilling is going on at present. Union is studying results of its long and expensive search which, to date, has been unproductive. The company will drill additional tests during 1959, it was announced.

Cuba. The revolution and discouraging results have slowed drilling to a halt. There were no rotary rigs operating at the beginning of the year.

Guatemala: Ohio Oil Co. scheduled an exploratory test for March 1959, and four other wells are to begin drilling early this year. Sloane Exploration Co. is planning to resume drilling, and may have done so by this time, on its No. 1 Carlos Castillo Armas. Esso Standard de Guatemala will drill late in 1959. Inversiones Guatemaltecas has contracted for three wildcats during 1959 in Izabal.

Haiti: A well was drilling by Commonwealth in the Cul de Sac basin at the end of 1958.

Honduras: No drilling is in progress pending passage of the new oil law.

Mexico: 119 rigs are operating in the country. In January 1959, the first offshore discovery was announced by Pauley Petroleum Inc., off Vera Cruz near Cotzacoalcos.

Nicaragua: No drilling is under way, and no drilling plans are known.

Panama: Champlin Oil, abandoned its first test, Anita Bay No. 1, at 9,537 ft. A second well, Almirante No. 1, was spudded about 35 miles west.

Delhi Taylor Oil Corp. has begun a five-year program, and was to begin its first deep test during early 1959 in the Chucanaque River basin.

Puerto Rico: Maritime Oil Co. plans a well early in 1959. No other wells are known to be planned.

Trinidad: Exploratory drilling is rising. One of the more active companies is Dominion Oil Ltd., subsidiary of Standard of California, which is operating an offshore floating platform. During 1958, Dominion took new leases over 1,581 areas south and east of the island, with drilling to start three months after award of leases.

EUROPE

Austria: RAG is running two rigs at present. At the end of 1958, one rig was drilling a southeast stepout from the 1956 Puchkirchen discovery; the other was drilling another wildcat, Uebersbach No. 1. No information was available on the government's activities.

Belgium: No wells are drilling at present. A press report that Petrofina was involved in a concession recently granted has not been confirmed by the company.

Germany (East): No information on the number of rigs active is available, but the total is certain to be small. A total of 426,530 ft is to be drilled during the coming two years, to fulfill plan target.

Denmark: Esso was on its 10th well on February 3, 1959, known as Lavoe. It was begun January 20, and is located on the Island of Zeeland (the same island which Copenhagen is on) north of Copenhagen.

Eire: No drilling is being done, but Ambassador Oil Corp. recently received a concession over most of the country. It requires a 5,000-ft test within two years.

Finland: No drilling is reported.

France: A number of new finds in the Paris basin highlighted the French search. The first was by Ste. de Réchèrches Pétrolières at Coulommes. The field is now believed to have about 15 million barrels of proved reserves. A second discovery in the same basin was by Fropex at Chateaurenard. Caltex owns 15% of Fropex; Cie d'Exploration Pétrolière owns the remainder. The company is now drilling its sixth well on a discovery made 70 miles south of Paris in 1958. Another find was at Chailly by Cie d'Exploration Pétrolière. Still another discovery was made at Nangis, by Régie Autonome des Pétroles in 1958. There are presently 17 companies drilling for oil. Meters drilled in 1958 totaled 29,453, 32% over 1957.

Germany (West): A number of oil discoveries were made during 1958, and the percentage of exploratory drilling rose sharply compared with development work. As will be seen in the accompanying tabulation, the number of drilling rigs active is quite high. Operations within the country are generally too complex to permit a detailed summary; reference is made for a more detailed review to WORLD PETROLEUM for September 1958, which covers the first half of that year.

Greece: Deilmann Bergbau, a German company, drilled with one rig in Greek Thrace during 1958, and thereafter discontinued drilling. There is no other company reported to be drilling.

Italy (including Sicily): Gulf Oil Corp. was drilling a deep test, which was below 8,000 ft in Ragusa field, Sicily, during early February. On February 3, a wildcat—known as Rocco—was drilling below 5,000 ft. Seventeen tests were drilling in Raguna field at last report.

On the mainland, Italy's State-owned oil company, Ente Nazionale Idrocarburi (ENI) had 11 geological parties out. SOMICEM, another ENI company, had eight geological parties active in central-southern Italy. Geophysical activity by ENI and affiliates continued at about the 1957 rate during 1958—AGIP with 13 crews out, and SOMICEM with seven. Cities Service is operating a joint-venture exploration program with Pan American in southern Italy.

Netherlands: At the end of June, the only exploring company, NAM (Nederlandse Aardolie Mij.) owned by Jersey Standard and Shell in equal parts, had one exploration rig in operation and one development rig. Two discoveries were reported during this period: at Moerkapelle 4, and at Werkendam 1.

Spain: An active campaign has been carried out by C. Deilmann Bergbau, a German concern [and by Valdebro, an American-Spanish (government) company, and two Spanish government companies, CAMPSA and CIEPSA]. Valdebro is working with two rigs. CAMPSA has been concentrating on geological work in recent months, as has CIEPSA. Bergbau had done detailed geological investigation: eight seismic party-months and eight gravity-party months through August 1958. No discoveries have been reported by any of the exploring companies. The country is now awaiting passage of the regulations to the new oil law which may start an oil rush.

Sweden: No drilling has been reported.

Switzerland: No wells are known to be drilling at present. The Moudon test in Vaud canton was dry during 1958. It was drilled by Gewerkschaft Elwerath.

United Kingdom: British Petroleum is drilling actively, mainly in the areas around East Midlands fields and the Mesozoics of southern England. A few small discoveries were made in 1958, at Mothhamsall, Corringham, and Cropwell Butler. END

General view of YPF Plaza Huincul main camp.

Exploration well in Santa Cruz: Road to Pico Truncado, southwest of Cañdon Seco.

Future outlook for oil production in Argentina

by Andrés Rozlosnik

With extensive sedimentary basins stretching from Tierra del Fuego to its northern borders, Argentina has vast areas which are worth exploration.

FOR a long time the importance Argentina may acquire among oil-producing nations has been recognized. However, thus far it has not even supplied totally its own domestic needs. This is due to many reasons—which will not be analyzed here—but in no way is it owing to any lack of promising areas for oil exploration.

In an earlier publication by the author,[2] ample details were given of the history of its exploitation. Maps showed the exact location of the fields which at that time were producing or discovered. In this article, we refer only to the present state of development and to the prevailing opinion about its future.

There are several oil-bearing basins in the country—some of them of great extent—which have been only generally studied by geologists and geophysical work, and poorly recognized by a small number of exploration wells. Nevertheless, in those parts of the basins in which structures are exposed to the geologist's eyes, rich oil fields were found and maintained in production for many years. Others have been discovered in the vicinity or not far from these by geophysical methods, and a large number by structure or stratigraphic deep drilling. This latter method has been practiced since 1927 in Argentina.

New fields constantly are being found, and some of them are more productive than older discoveries. An accompanying map shows the different basins in their potential extensions and, in red, the oil fields which are in exploitation.

Starting from north to south, the first we find are:

1. *The Chaco-Paraná basin:* This is distinguished in its extreme north, in Salta, by the presence of a greater thickness of Gondwana, for which reason this area used to be called also "Gondwana basin." As a matter of fact, it might be considered as a separate one, since its ancient connections with the Chaco-Paraná basin are not quite established. Towards the north, the Gondwana basin enters in a larger extension into Bolivia, with its well-known productive oil fields.

In Argentina as well as in Bolivia, long strings of steep hills are exposed in that region, oriented from north to south, which correspond structurally to a series of strongly folded anticlines complicated by faults and even overthrusts.

Following the order from west to east of the structure lines and from north to south of the fields, we have:

a. Aguas Blancas; Río Pescado.

b. San Pedro; Ramos.

Andrés Rozlosnik, consulting engineer in Argentina, is a native of Hungary, where he received his technical training as a mining engineer. He was an engineer for the Hungarian government, engaged in oil and gas exploration in Transylvania, prior to his employment in 1921 by D'Arcy Exploration Co. Ltd., which was granted an oil exploration permit covering the entire country.

In 1923, Dr. Rozlosnik went to Argentina to become chief of drilling and production at Comodoro Rivadavia. In 1934, he was transferred to Buenos Aires, and appointed head of the exploration department. He resigned from YPF in 1946. He was a lecturer on drilling in the graduate school of the University of Buenos Aires from 1939 to 1946. Since that time he has been engaged in consulting work. He is a naturalized citizen of Argentina.

Exploration well in Mendoza.

c. Cerro Tartagal; Lomitas; Tranquitas.

To the east of this last anticline, we pass into the great plain of the Chaco, out of which in Argentina, but only in its northwest corner, emerge Tertiary formations with indications in their outcrops of more gentle classic structures. On one of these, by well C.D. 6 at 3,614 meters, was discovered in 1950 the big Campo Durán field and later Madrejones, farther to the north on another one.

Although these structures were known a long time ago, certain difficulties—such as the bit-wearing composition of the formations and the depth, then considered a great one—have delayed its discovery. At present those two fields involve, according to official estimates,[2] reserves of some 65 million cubic meters. However, since the oil is of the condensate type, whose treatment requires a special technique, and the disposal of the large-volume gas, exploitation of those fields is awaiting the finishing of certain installations as well as the products line to San Lorenzo and the gas line to Buenos Aires. To achieve the highest recovery and best economy, the building of these facilities was unavoidable.

The Chaco-Paraná basin extends, as is indicated on the map, in Argentina north to the border of Brazil and Uruguay and, through the former, as far as the Atlantic Ocean. It also covers, in the north, part of the republic of Paraguay.

There may be a controversy over the oil possibilities of that enormous extension, the exploration of which is handicapped by great natural difficulties; but in those neighboring countries, and in Argentina, so little has been done that, at present, pessimism is not justified. Besides, it is hard to admit that Campo Durán and Madrejones should be the best and only fields with no others to be discovered—although, according to our present knowledge, it might be risky to predict at what distance there are major possibilities of finding oil.

2. *The Triassic basins:* In this much more reduced area than the former, taking again the axis of the structure lines from west to east and the fields, in each of them, from north to south:

a. Cacheuta; Tupungato; Piedras Coloradas.

b. Lunlunta; Barrancas; Carrizal; Río Tunuyán; La Ventana; Punta de la Barda; Vacas Muertas.

All these fields are located on structures which are visible for geological studies. In the plain extensions of these basins, geophysical studies have been made, and some drilling afforded valuable data for future work. Some oil shows were found. While these are not conclusive, they do invite new and more intensive studies.

The oil of the above-mentioned fields is light and of paraffinic base. The proved reserves are officially estimated in Mendoza at 80 million cubic meters.

3. *The Mesozoic geosyncline of Neuquén* spreads over a part of the provinces of Mendoza, La Pampa, and Río Negro. It is one of the oldest zones in exploitation, but its production has been increased in the past several years. The difficulty of locating fields in this basin lies in the fact that the structures, little pronounced as they are, are complicated by discordances and truncations. It is partly due to the same reason that the proved reserves of this basin thus far are not great and do not exceed 15 million cubic meters. The oil is of the light type.

The principal fields, which are not so well aligned as those of the former basins, are:

a. A group of 10 oil fields in Plaza Huincul and its neighborhood.

b. Cerro Bandera; Cerro Atravesado.

c. Challacó; Del Medio.

d. Cerro Lotena.

e. El Sauce.

To this basin belong the fields of El Sosneado and Pampa Palauco in South Mendoza, both of little importance at the present time. They produce a very heavy asphaltic oil.

4. *The basin of the Gulf of San Jorge* was the first zone in Argentina in which oil was produced after the discovery of the Comodoro Rivadavia field in 1907. Likewise, it has been the largest producer ever since. Its proved reserves total some 180 million cubic meters of oil.

On its northern flank, to the north of the village of Comodoro Rivadavia, the following fields have been producing for a very long time: the so-called Campamento Central, which extends practically up to Caleta Córdoba; the field of the Astra Co. to the north; that of Diadema and Escalante to the west; from here to the north, Manantiales Behr; and to the southwest of those, El Trébol and El Tordillo. To these fields recently were added, in a westerly direction, Pampa del Castillo, Cañadón Grande, Cerro Dragón, and Cañadón Pedro.

The exploitation of the southern flank started in 1945, in Cañadón Seco—to which were added later: Cañadón León, Meseta Espinosa, El Cordón, and Tres Lagunas.

Finally, since 1956, at quite a distance to the west, the Colonia Sarmiento field has been producing.

In some parts of this basin the oil is heavy, but in the largest portion of the fields it is fairly medium and light—always of asphaltic base. Drilling conditions are very easy; depths rather shallow; gentle structures affected by faults.

5. *The Magallanian basin* comprises an

Zone	Number of Wells Drilled	Number of Producing Wells	Production (Cubic Meters) 1957	1st 6 Months 1958
Golfo de San Jorge	8,103	2,564	3,137,786	1,587,571
Neuquén	1,335	518	676,547	340,187
Salta-Jujuy	524	178	145,685	87,933
Mendoza	395	245	1,437,840	674,424
Totals	10,357	4,505	5,397,858	2,690,115

area which extends from the eastern Cordillera and covers, in Argentina, the major part of the province of Santa Cruz; it extends to the north approximately to the 43rd parallel. It is in this basin that Chile operates its oil fields, but on the Argentine side the basin has not yet been extensively explored. Only in Tierra del Fuego, to the north of Río Grande, a field of light oil and gas was discovered, but this is still in development and not exploited regularly.

The estimated reserves of this zone are included in the figure belonging to the basin of the Gulf of San Jorge.

6. *The Mirihuan basin:* Possibly this is a basin of reduced extension, with only one producing well which yields a small quantity of a very heavy oil. In view of the relative importance attributed to this area, it has not been a matter of special attention.

7. *and 8:* These numbers mark, on the map, two basins of not very great extent: the Río Salado basin, and that of the Río Colorado. The first may or may not have connections with the Chaco-Paraná basin previously discussed. It has been recognized by geophysical methods, and a well was drilled by YPF to a depth of 4,012 meters without reaching the basement. Its possibilities may be compared to those of the big northern basin just mentioned.

With regard to the Río Colorado basin, its existence was presumed a long time ago and later proved by geophysical studies. Drilling was carried out mainly for water in this basin, except the Pedro Luro well of 3,278 meters, drilled for oil by YPF. None of these reached levels sufficiently deep to give a more concrete idea about its oil possibilities.

Summing up, the country possesses proved reserves of about 370 million cubic meters of oil, to which may be added those of natural gas estimated by the same official sources at about 100 million equivalent cubic meters of oil. Some gas lines have been laid to consuming centers to make use of the gas, and others are being constructed at present.

Production: The following tabulation gives the number of wells and the production attained in 1957 and in the first six months of 1958 for each basin:

So far, exploitation has been rather conservative in Argentina, if we consider that the oil-producing nations of the world recover as a whole an average of 5.5% of their total reserves each year, except the Middle East which produces less than 1% of its reserves. Thus, we believe that it will be feasible to increase the production of Argentina to a degree which will satisfy all the needs of the country. However, measures must be taken not only to replace the reserves which diminish with the volume of oil produced, but also to increase them in proportion to the increased production by undertaking more ambitious exploratory work.

In planning the extent of exploration in future years, one should not take as a base the exceptionally high rate of finds obtained in the past. In this new campaign, the work will not be limited to the neighborhood of existing fields as has happened, with few exceptions, before. It will not be possible to select only the shallow zones, areas of easy access, as formerly; nor, as formerly, to choose out of a large number of locations only the most promising. A greater proportion of trained technical personnel will be required, and many studies conducted. On the other hand, it is to be expected that the ever-improving techniques and new instruments will contribute so that the work may be accomplished perhaps more easily than is feared at this moment.

Conclusions: Argentina contains sufficient oil reserves to fulfill its program of intensifying production so as to satisfy its total necessities in a short time. The country has large appropriate areas to explore not only to replace the reserves which are being reduced by exploitation, but also to increase their volume through new production methods. Extensive exploration work must be faced, and measures must be taken that it be accomplished regularly if adequate supplies of oil are to be maintained for many years.

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Seismic party in Neuquen.

Wildcatting in Neuquen.

Aklavik, the town which is to be moved across the delta to East Three (all photos in this article courtesy of Shell Oil Co.)

Shell Otter and Bell 47-J helicopter Margaret Lake in the Yukon while the pilots and field party discuss the next move.

North of the prairies

by Hugh Harvey*

From a base on the delta of the Mackenzie River, more than 1,200 miles north of Edmonton, Shell Oil Co. of Canada Ltd. is conducting a reconnaissance of the vast sedimentary belt on the eastern slope of the Rockies.

North of Canada's Prairie Provinces, and extending as far east as Baffin Land, lies a wilderness which has offered a challenge, often fatal, to the hardiest of explorers. Known as the Northwest Territories, it is an area of some 1,300,000 square miles, extending from the Yukon in the west to the western straits off Greenland and as far north as the pole. Dotted by lakes as numerous as the stars in the sky, and etched by rivers and streams, it is the land of muskeg and tundra. Beneath its moss-covered surface lurks the unconquerable permafrost which refuses to bear the weight of buildings and roads, runways, and plumbing—the necessities of civilization.

Forests clothe the southern reaches of the territories; but in the north, with perhaps the exception of the Mackenzie River delta, the trees dwindle and finally disappear, until all that is left is the barrens or wind-swept plateaus covered only by the arctic moss and innumerable species of dwarf flowers. Beyond the shores of the ocean lie the islands of the arctic archipelago, a region of utter desolation inhabited by a few Eskimo tribes who eke out their existence on the shores of the sea.

Perhaps if it had not been for World War II, Canada's northwest might have continued to lie dormant, the last refuge of the lone trapper and the home of the Eskimo and such Indian tribes as the Hare and Dob-Rib and the Loucheaux, the tribe which has given us the proverb "Let me not judge my brother until I have walked two weeks in his moccasins." Canadians have long known their northern empire is rich in natural resources; for the earliest explorers, including Alexander Mackenzie in 1789, had brought back reports of burning seams of coal. But the obstacles to exploration and development were insuperable. During the summer months overland travel is avoided even by the Indians and Eskimos; for trails or roads in the tundra turn into quagmire and the surface it presents in the virgin state makes progress very slow. Mosquitoes, which stream out of the ground like jets of water, make life almost intolerable; and, strange as it may seem, the heat of the arctic summer, combined with the humidity, deprives even the most rugged individual of the strength to carry a pack. Winter, when the ground is frozen solid and covered with snow, is the season for traveling, and the population moves about by dog sled and snowshoe.

The eastern part of the Northwest Territories is made up of the Precambrian Shield, while from approximately 200 miles east of the Mackenzie River westward there are great sedimentary deposits, an extension of the ancient ocean floor which runs all down the eastern slope of the Rockies. It is a formation in which have been found many petroleum deposits like those in Montana and the Leduc field in Alberta. In the valley of the Mackenzie, oil was found as long ago as 1920 in the region around Norman Wells, 940 air-miles north of Edmonton. A refinery was built at Norman Wells, and during the war a pipeline took product from this refinery 589 miles westward to Whitehorse in the Yukon. The pipeline has been torn up, but the refinery is still operating, furnishing all the fuel for the Mackenzie basin. In 1930, silver-pitchblende was found near Great Bear Lake; and today there is a large installation at Port Radium, on the east end of the lake, for recovering silver, copper, cobalt, and lead, as well as radium and uranium, the concentrates of which are shipped by air to Port Hope, Ontario, for further treatment. While not a natural resource, one of the contributing factors to the opening up of this country is the DEW line, a chain of early-warning radar stations all across the north at approximately 50-mile intervals.

Ever since the war, Canada has been concerned with exploring the hidden resources of its northern territories; and in the spring, when the ice leaves the lakes, parties are flown into the bush where they stay until snows threaten to make their work impossible. Typical of these explorations are the studies being made by the Calgary exploration organization of the Shell Oil Co. of Canada, Ltd. To support the parties in the field, Shell has a DC-3 based at Edmonton. During the summer months, this aircraft operates on a regular schedule up the Mackenzie River 1,297 miles to East Three, or what will probably be known in years to come as New Aklavik. Here Shell has a base camp on the shore of a lake from which two Otters can fly supplies to the field camps. At each field camp, a helicopter is stationed to transport the field geologists about the sections under study.

In addition to the helicopters assigned to

* Technical publicity department, Shell Petroleum Co., London. This article was written by Mr. Harvey for *Shell Aviation News*, and is reproduced here in part, through the courtesy of B. J. Haines, editor.

Bell helicopter operating over Rat River in the Richardson Mountains in the Yukon; The white patch at lower right of the picture is a glacier.

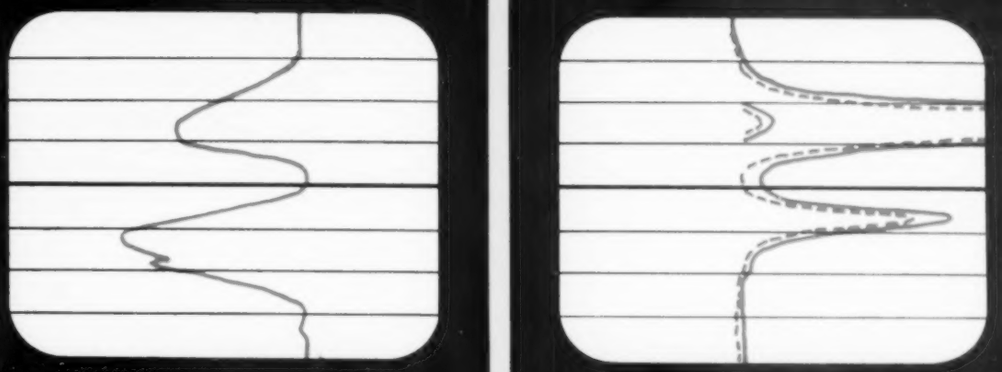
the camps, there is a roving helicopter carrying a senior geologist who goes from camp to camp. The DC-3 covers the 1,200 air-miles from Edmonton to East Three in approximately nine hours. Its cargo consists of mail, fresh meat and vegetables, and fresh milk which is in great demand in the camps, plus such staples as canned goods and all replacement parts for equipment in the field. Stops are made for fuel at Fort Simpson, 640 miles from Edmonton, and again at Norman Wells, 297 miles farther up the river. At East Three, it lands on the new airport which is being constructed over the permafrost by Eskimo labor, using the latest mechanical equipment.

The construction of the airport and the new town of Aklavik at East Three is an engineering endeavor which is being watched by all interested in development of the arctic. Old Aklavik, nearly 50 miles away on the west side of the delta, is to be abandoned, since its situation prohibits further development. Its wooden buildings,

Shell field camp in the Richardson range in the Yukon.

Below, 'air terminal' at Aklavik with a CPA Otter in the foreground.

THE eyes OF THE OIL INDUSTRY



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resting on top of the ground, are gradually sinking as the heat generated in them melts the frozen soil. Running water is obtained by the bucketful from a pipe aboveground which snakes its way from a nearby lake through the town. In winter, when the lake is frozen solid, drinking water is obtained by melting ice blocks taken from the river. There is no sewer system. No suitable site exists for an airport; and, until the airport at East Three became operational last year, all wheel traffic had to stop at Norman Wells, and the rest of the journey was made by light aircraft equipped with floats.

With the gradual opening up of the north, the Canadian government decided that a new town must be built, and a survey was made of the delta for a new site. East Three was finally chosen, it being the third site on the east side of the river which was surveyed. Here, at a cost of some $100 million, the new town is being built, using techniques for constructing on the permafrost which have been developed by Canada's National Research Council. Foundations for the buildings are piles which are inserted some 30 ft into the ground by boring holes in the frost. These posts, which are floated 700 miles down river, are allowed to set for a year or more before construction continues. When they are solidly frozen in position, they are cut off about 4 ft above the ground and the buildings then erected on them. The air space, plus well insulated floors, is expected to provide the insulation necessary to prevent settling of the structures. At the airport, which is on a rise of ground about seven miles from East Three, the runway is being constructed of crushed rock on top of the moss which has carefully been left undisturbed so that it will retain its ability to insulate the frozen ground. It is estimated that 9 ft to 14 ft of filling will be required for a stable surface. Because it is essential that the permafrost remains solid beneath the runway, thermocouples have been placed in it, and readings are being taken every week to monitor the effectiveness of the rock fill in keeping it from melting. About a quarter of a mile from the airport is a lake from which light aircraft on floats fly to other points.

The cargo of the Shell-operated DC-3 is transferred to a truck at the airport and taken to the base camp, where it is broken down for distribution to the various field camps by the two Otters. Fuel is trucked in to the base camp from the barges which stop at East Three; and one of the chores of the camp personnel is to transfer the fuel to 10-gal drums for supplying the fuel caches at the field camps.

Field camps may extend some 200 miles east of the Mackenzie to where the barrens begin, or westward the same distance into the jagged mountain ranges which form the northernmost ramparts of the Rockies. All flying in this country is done under VFR, since there are no navigation aids and the ordinary compass is next to useless. To the experienced pilot, the landmarks are unmistakable; but to the passenger making his first trip, it is a land of confusion. The sun in mid-summer never sets, and without the aid of a watch it is an unreliable indicator of north and south, east and west. Looking down on the seemingly endless delta of the Mackenzie, one sees a vista of innumerable lakes and writhing and twisting channels of muddy water which seem to go nowhere. Eastward, the land rises to form a plateau the surface of which is bare except for stunted trees which huddle in hollows along the beds of streams. Lakes laced with water lilies are everywhere, each the home of a pair of white swans who swim side by side with majestic pride across the rippled waters. Occasionally, the aircraft crosses a river which has cut a deep chasm into the highland. For the inexperienced, these rivers are the only landmarks which can be correlated with the map. In wintertime, this area is covered with drifting snow. From the air, it may look like a solid surface; but an unlucky pilot who tries to make a landing often finds himself lost in a blizzard 25 ft thick, with visibility zero.

West of the delta, the land changes in character. The rivers flow in wide, gravely beds; and, as the land rises toward the mountains, the lakes become less numerous. Erosion of the great uplifts has given rise to plunging cliffs, and the everlasting action of the frost has clothed the slopes with scree. Here and there, broad valleys nestle at the foot of the peaks; and, because they have been protected from the arctic winds by the surrounding mountains, tall timber grows.

Occasionally, on the shore of one of these lakes, will be found a trapper's cabin, more likely than not abandoned, particularly during the summer months. His homemade snowshoes will be hanging by the door along with his skin stretchers. Inside, the few necessities he needs rest on improvised shelves: a box of matches, some ointment he smears on his traps to kill the odor of man, a gold pan filled with ammunition of all calibers and, on the wall, an old calendar—the year changed and the days painstakingly X'ed off by a carpenter's blue crayon hanging on a string.

At such a site last summer, Shell had pitched a field camp. Saplings had been cut and driven into the shallow lake on which had been built a small dock for unloading the Otters. The heliport was a little point jutting out into the water, its edge rimmed by 10-gal drums of fuel. The old cabin of the trapper, with its thick sod roof, was cool inside and was being used to store the food supplies. Two tents stood side by side, each with an end open except for the zippered mosquito net; one served as the cook tent, and the other the dining room. Scattered about the clearing were five or six smaller tents, each furnished with a cot and a crude bureau which was nothing more than an empty dynamite case.

Over a breakfast of bacon and eggs, hotcakes, and fruit juice, the party chief outlines the plan for the day. Maps are spread out, and the jargon of the geologist flies thick and fast. The pilot of the helicopter is usually puffing away at his pipe and making mental notes of the fuel he will need, the passes he will have to vault, and the escarpments he will have to scout for landing sites. The geologists, he has discovered, regard his "chopper" as though it were one of the elevators in Radio City. Meanwhile the mechanic, who is stationed at each camp, is loading the fuel—42 gal to fill the tanks—and checking the machine from rotors to floats.

Once the plan for the day is crystallized, the geologists, or it may be a geologist and a paleontologist, climb into the plastic bubble and strap themselves tight. Mosquitoes are blown in clouds from the tundra as the blades rotate during the warming of the engine. Then, with the abruptness of a dragonfly, the helicopter rises and darts off on its mission. In less time than it takes to launch a canoe, the airborne prospectors are two miles from camp. Deftly, the pilot has skirted the rising terrain, taking advantage of ground effect and updraft on the slopes to gain altitude. Ridges are scaled and deep valleys crossed with effortless ease, and the area to be studied is reached in minutes instead of hours or days. Once on location, the helicopter jumps from valley floor to craggy peak, resting briefly on a sandbar or perching on a knife edge between the scalloped crests of the mountains to permit the geologist to examine the outcrops and take pictures for his notebook with his Polaroid camera. Conservative estimates show that the helicopter in the north country permits a geologist to accomplish in 90 min. what it would take three or four days to do if he had to rely on surface transportation. Thus, while the out-of-pocket expense of chartering helicopters is not small, being in the neighborhood of $7,000 a month plus $16 an hour flying time, the overall savings are considerable. At the same time, there is virtually no other way to travel about the country during the summer, unless it is in a light aircraft on floats; but, naturally, a fixed-wing aircraft does not lend itself to the flexibility of the helicopter which combines the fleetness of the caribou with the agility of a mountain sheep. END

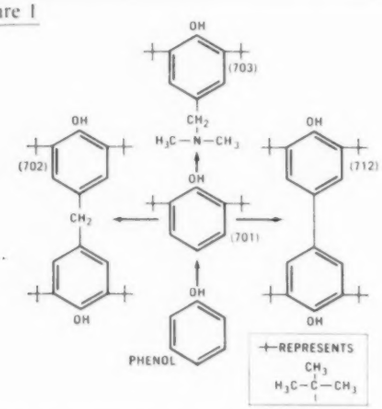
Discovery of "Ortho-Alkylation" reaction makes possible a new series of antioxidants for petroleum and petrochemical products

ETHYL'S DISCOVERY of the "ortho-alkylation" reaction has made available commercially, for the first time, a whole new series of phenol and aniline derivatives alkylated in the two and six positions.

All of these compounds are excellent chemical "building blocks" because of the open reactive para position on the benzene ring. (Figure 1)

Exhaustive evaluation has shown that many of these compounds have superior antioxidant characteristics in specific petroleum product applications.

Figure 1



Phenol and iso-butylene are combined by Ethyl's patented "ortho-alkylation" process to form 2,6-di-*tert*-butylphenol (701). This compound, with the open reactive para position, is a chemical "building block" for other important additives.

"Ethyl" Antioxidant 701— A Gasoline and Jet Fuel Additive

One of these compounds, 2,6-di-*tert*-butylphenol, is an excellent gasoline and jet fuel additive for inhibiting the formation of gum and other oxidation products. This compound is available commercially as "Ethyl" Antioxidant 701 and in a more economical form as "Ethyl" Antioxidant 733.

The importance of 2,6-di-*tert*-butylphenol is increased by the fact that its derivatives contain the hindered phenol structure which is characteristic of effective phenolic antioxidants. This led Ethyl Research in the direction of many possible additives.

701 Also an Intermediate to Other Additives

Early work showed that a highly effective structure pointed to a compound in which the two and six positions were occupied by *tert*-butyl groups. The four position was then used to test substituents in experiments designed to modify the 2,6-di-*tert*-butylphenol structure in order to obtain improved antioxidants.

"Ethyl" Antioxidant 702. A Lubricant Antioxidant and Anti-Wear Agent

Lubricant applications involve elevated temperatures and aeration and thus it was desirable to examine structures having minimum vapor pressures. This suggested compounds with higher molecular weights that still retained desirable antioxidant properties.

One important additive resulting from this work is 4,4'-Methylenebis(2,6-di-*tert*-butylphenol) ("Ethyl" Antioxidant 702), an exceptional lubricant antioxidant. It is a low volatility, non-sludging, temperature-stable, phenolic antioxidant and anti-wear agent.

Numerous laboratory and field tests were used in examining the characteristics of "Ethyl" Antioxidant 702:

Antioxidant Evaluations

ASTM Steam-Turbine Oil Tests • Panel Coking Tests • Automatic Transmission Tests • CRC L-4 Tests • Modified Polyveriform Tests • EMD Silver Corrosion Test

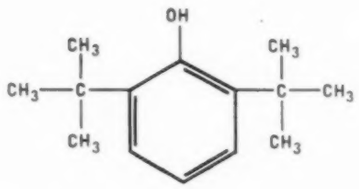
Anti-Wear Evaluations

CRC L-4 Tests • Chevrolet "Full-Throttle" Tests • "Hot-Ring" Tests • CRC FL-2 Tests

"Ethyl" Antioxidant 702 has found application in crankcase oils for gasoline and diesel engines. Both oxidation and bearing corrosion are inhibited (Figure 2) and scuffing-type piston ring wear is minimized.

The compound is finding increased use in railroad diesel engine oils and in other applications where copper, silver and bronze parts are critical. In all evaluations, oil treated with "Ethyl" Antioxidant 702 showed outstanding improvement.

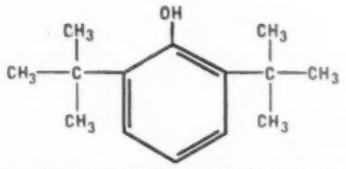
701—2,6-Di-*tert*-butylphenol



In motor and aviation gasoline to inhibit oxidation during storage; in jet fuels to inhibit oxidation during storage; and in industrial oils to inhibit oxidation.

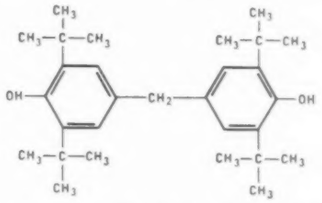
733—2,6-Di-*tert*-butylphenol (75% min) 2,4,6-Tri-*tert*-butylphenol (10-15%) Ortho-*tert*-butylphenol (10-15%)

(75% Min.)



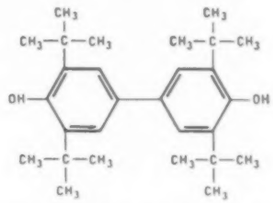
In motor and aviation gasoline to inhibit oxidation during storage; in jet fuels to inhibit oxidation during storage; and in industrial oils to inhibit oxidation.

702—4,4'- Methylenebis (2,6-di-*tert*-butylphenol)



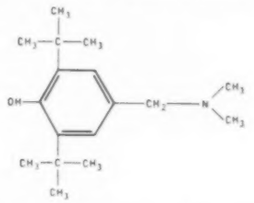
In motor oils for both gasoline and diesel engines to inhibit oxidation and minimize scuffing-type piston ring wear; in automotive transmission fluids and industrial oils to inhibit oxidation; and in plastics and rubbers to inhibit oxidation.

712—4,4'-Bis (2,6-di-*tert*-butylphenol)



In petroleum-based oils for high-output engines to inhibit oxidation and minimize scuffing-type piston ring wear; in diester-type synthetic oils to control oxidation and deposit formation; and in plastics and rubber to inhibit oxidation.

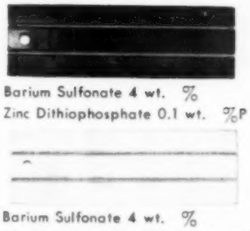
703—2,6-Di-*tert*-butyl-α-dimethylamino-p-cresol



In motor oils, greases and industrial oils to inhibit oxidation and impart alkylinity, dispersancy, anti-rust and anti-wear properties; in diester-type synthetic oils to inhibit oxidation during storage.

EMD SILVER CORROSION TEST

Silver coupons from railroad diesel engine oil test at 275°F. for 72 hours.



Barium Sulfonate 4 wt. %
Zinc Dithiophosphate 0.1 wt. %P

Barium Sulfonate 4 wt. %
"Ethyl" Antioxidant 702 0.7 wt. %

Figure 2

How Ethyl Research is helping you

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ITALY— a résumé of exploration and production

SURFACE traces of oil and asphalts, and natural-gas emissions, have been known in Italy since ancient times. Following traces of these surface manifestations, the first drilling activity, which took place mainly in the sub-Apennine regions south of the Po valley, brought Italy on the list of oil-producing countries at the dawn of the petroleum industry. In the early statistics, Italy is present with major oil-producing countries like the USA, Russia, and Romania.

The intricate geologic aspect of the areas more favorable to oil production hampered research work and the successful development of the oil and natural-gas resources of the country. Exploration and drilling was first encouraged by the government in the '30's, when national politics aimed at self-sufficiency in every possible field (with meager results, however, in petroleum production). Later on, the introduction of modern methods of geophysical prospecting, and the extension of geological surveys to the whole nation, resulted in the location of areas of more favorable aspects for petroleum exploration in the Po River valley, in the sub-Apenine areas on the Adriatic side of the peninsula, in the plateau of Puglie, and, much later, in southeast Sicily.

The Western Europe map of the OEEC[1] classifies the areas of Italy, as far as petroleum geological aspects are concerned, into the following classes:

1. *Decidedly unfavorable* (crystalline rocks).

2. *Unfavorable* (parts of the sedimentary basins where tectonic conditions have destroyed the original asset).

3. *Reasonably favorable* (sedimentary basins partly explored in the upper parts, still unknown at higher depth).

4. *Favorable* (sedimentary basins characterized by thick deposits, in which oil or gas has been found, or in which the geologic conditions are analogous to the latter).

Under the above classification, the territory of Italy (301,081 square kilometers) can be subdivided as follows:

Class 1—68,823 sq km (22.8%)
Class 2—78,501 sq km (26.1%)
Class 3—69,722 sq km (23.2%)
Class 4—84,035 sq km (27.9%)

At the present status of development of studies and field work, exploration in Italy is centered in the following basins and areas:

The Po valley basin: The neogenic series of the Po valley, being made of alternating reservoir rocks (sands, sandstones, conglomerates) and of cover rocks (clays and marlstones) is considered highly favorable to oil and gas accumulation. In fact, hydrocarbons are found very often in this area, mainly as dry gas or slightly wet gas (in lower Pliocene and upper Miocene). In 1957, the area produced 4.2 billion cubic meters of natural gas and about 62,000 tons of light crude oil and condensate liquids. Producing levels are from lower Pliocene to upper Oligocene. Natural-gas reserves of the area are conservatively estimated above 120 billion cubic meters.

In the Po delta area, near the Adriatic Sea, (Polesine) natural gas associated with salt water is produced from shallow wells drilled in the Quaternary. The origin of this gas is generally attributed to lateral migration from Pliocenic faulted structures.

The Po valley reservoirs, with the exception of the shallow Po delta accumulations, are generally found at depths ranging from 850 to 3,000 meters. Four wells have been drilled below 4,000 meters, one of which reached 5,251 meters, which is the deepest well in western Europe. The Po basin covers an area of 52,900 square kilometers.

Apennine-Adriatic basin: The southeastern part of the Po basin is connected to the Pedemontane areas of the Marche and Abruzzi regions. Total area of the basin here is 9,800 sq km. A small natural-gas field has been found near Rapagnano (Marche); two oil fields of small extension (Alanno and Valle Cupa) have been discovered. The second is being exploited. The two oil fields are in organogenous limestones of lower Miocene.

Basin of the Tertiary Molasses: The basin lies westward of the former. Total thickness of Oligo-Miocenic sediments is above 4,000 meters. The Miocenic part in Emilia and Marche regions is particularly interesting for exploration in the Miocenic Molasses series. Total basin surface is 8,400 sq km.

Exhaustive reports on several wells of the more important gas fields of the Po valley have been recently published by AGIP-Mineraria (ENI group)[2].

Area of the "Argille Scagliose": Several traces of hydrocarbons have been found in the porous and permeable horizons of this heterogeneous formation. Special interest is attributed to the autochtonous series underlying the "argille scagliose"; the area of the argille scagliose covers about 5,800 sq km.

Other continental areas: Other areas considered of interest for oil and gas exploration are the small neogenic basins of Tuscany (5,300 sq km), the zone of limestones in Umbria and Marche regions (6,300 sq km), the flysch zone in Campainia and Lucania (11,500 sq km), and the plateau of Puglie (20,100 sq km).

Sicily: The recent discoveries of substantial amounts of crude oil in Sicily, and the

Fig. 1 Drilling activity in Italy (thousands of meters drilled monthly), 1956-58.

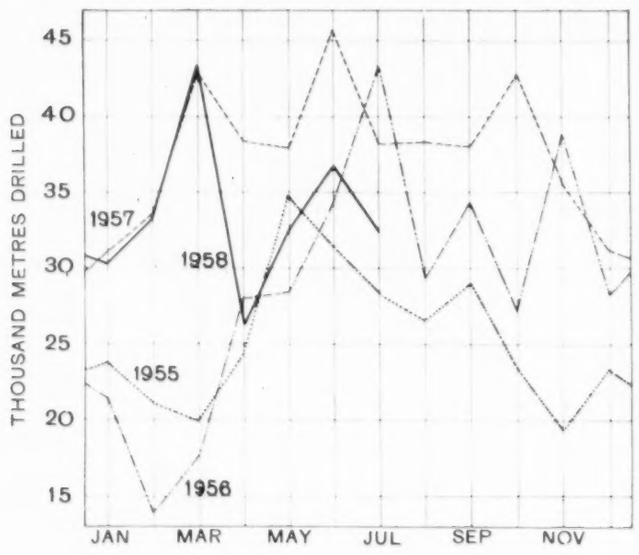
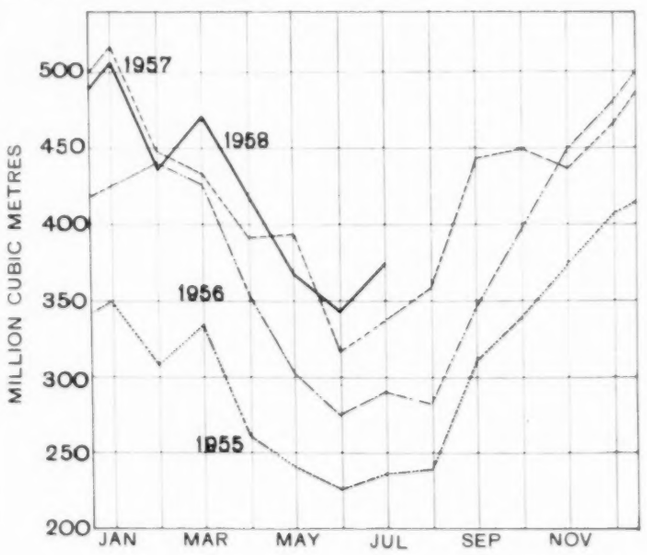


Fig. 2 Production of natural gas (millions of cubic meters monthly), 1956-58.



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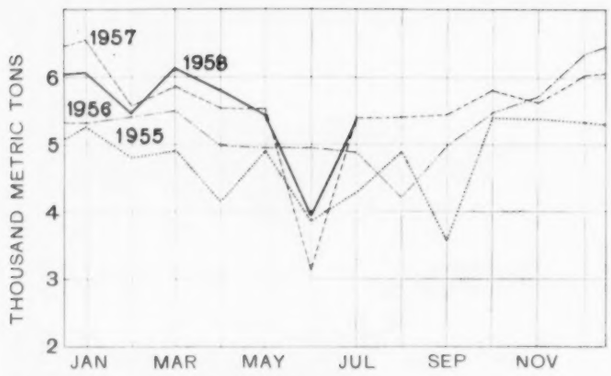


Fig. 3 Production of natural-gas liquids (thousands of metric tons monthly), 1956-58.

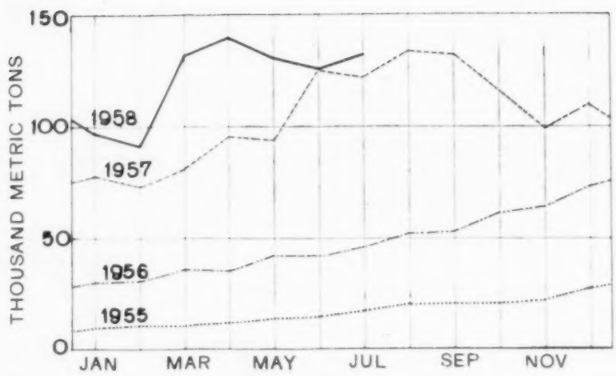


Fig. 4 Production of crude oil (thousands of metric tons monthly), 1956-58.

active exploratory work under way, make Sicily the hot spot of the whole country. Interesting basins of Sicily are the following.

Foreland: In this area the greatest Italian oilfields are located, viz., Ragusa and Gela. The reservoir rocks are Triassic limestones and fractured dolomites. Surface of the area is 2,500 sq km; sedimentary thickness is over 4,000 meters.

Tertiary basin: Several traces of oil are found in this area. Thickness of the basin's formation is above 7,000 meters in the south-central part of the island. Prospects are also good owing to the presence of porous and permeable strata with superimposed good clay impermeable cover. Tectonics is generally complex. Surface of the basin is about 4,200 sq km.

Exploration is considered interesting in the Tertiary series, where indications are known, and where permeable and porous formations are covered by impermeable strata. This area covers 13,700 sq km.

Quaternary basins: Four small natural-gas reservoirs have been found in the marine Quaternary in the plain of Catania. The Quaternary basins have the very limited extent of 800 sq km.

Results of Explorations in Italy: Fig. 1 gives a resume of drilling activity in Italy (thousand meters drilled monthly) from January 1955 to March 1958. The data are inclusive of all kinds of drilling (wildcat, extension, development, etc.).

In studying Italian statistics on drilling, it is often difficult to distinguish between real exploration drilling (wildcatting) and drilling aimed at the delimitation of fields and at their development. Italian statistics of drilling activity do not conform to the USA classification of exploratory drilling as established by Lahee[2].

According to OEEC statistics[1], wildcatting activity in Italy from 1950 to 1957 may be summarized as follows:

Number of wells drilled	297*
Of which producing	65
Total meters	548,000
Average depth, meters	1,850

* Shallow wells in the Polesine area not included.

The above figures must be considered as rough approximations.

Exploration activity is presently scattered over the whole country, in the favorable areas listed above. Highest activity is centered on three main areas: Po valley, Abruzzi, Sicily.

Activity in the Po valley by companies of the ENI group has recently resulted in the discovery of four new gas pools, extending Italy's more interesting area toward southwest, north-central, and southeast.

The recent discoveries, joined to the extension of previously developed gas fields, will increase natural-gas production in Italy from the present 4.5 to 6 billion cubic meters per year, proved reserves being about 25 times the latter figure.

The condensate field of Cortemaggiore, discovered in 1949, produces about 50,000 tons per year of a high-grade sweet crude

(Continued on page 97)

Fig. 5 Geologic sketch of Ragusa oil field (Sicily): Rag.S—Upper Ragusan; Rag.I—Lower Ragusan; Cr.S—Upper Cretaceous; Cr.I—Lower Cretaceous; Gs.M—Upper-Middle Jurassic; Ls.—Lias; T—Trias.

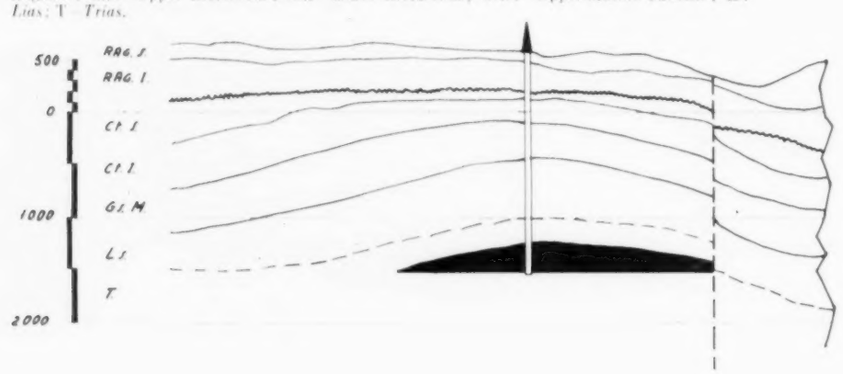
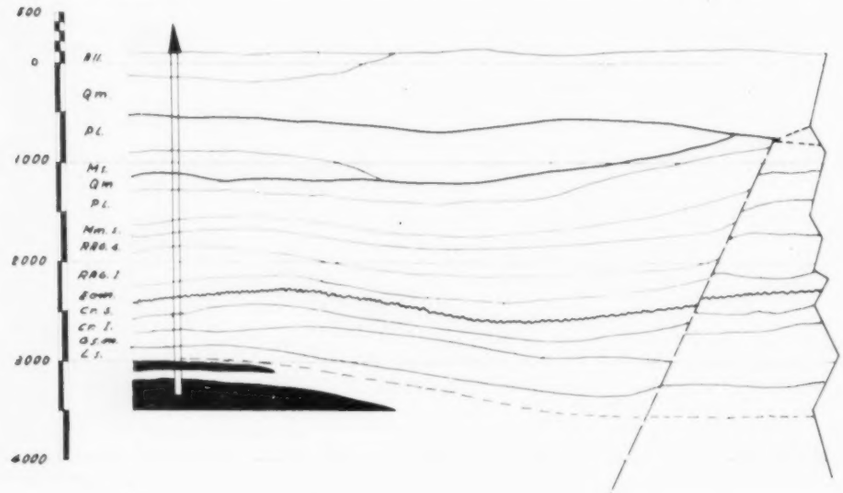
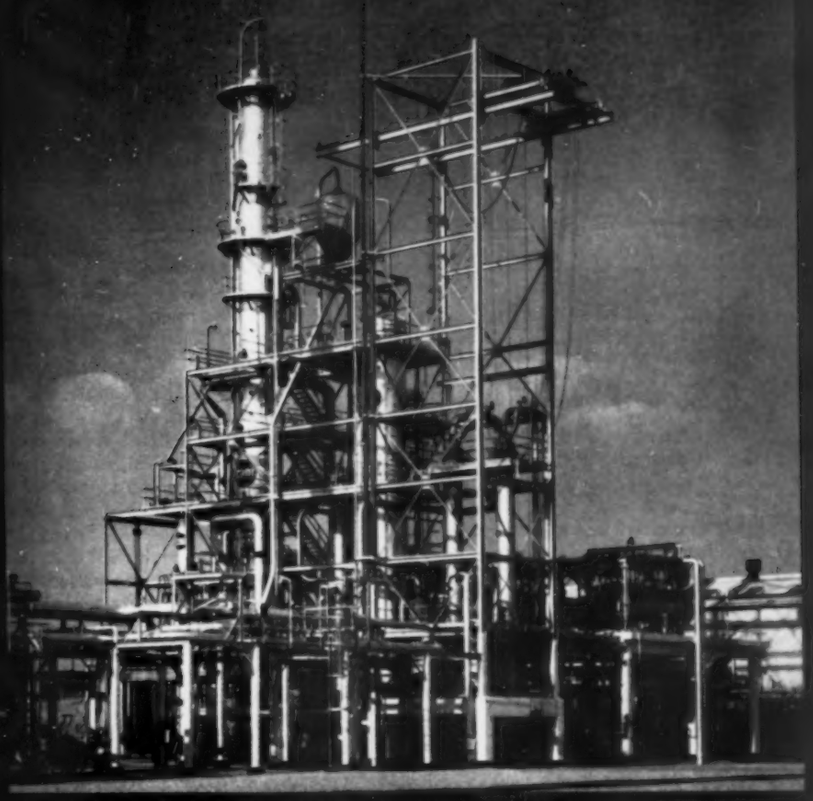


Fig. 6 Geologic sketch of Gela oil field (Sicily): All.—Alluvial; Qm.—Quaternary; Pl.—Pliocene; Ms.—Upper Miocene; Mm.s.—Upper-Middle Miocene; Rag.S—Upper Ragusan; Rag.I—Lower Ragusan; Eom.—Eocene; Cr.S—Upper Cretaceous; Cr.I—Lower Cretaceous; Gs.M—Upper-Middle Jurassic; Ls.—Lias.





The photographs show the Hydrodesulphurisation Unit at Shell's Stanlow Refinery and are by courtesy of the Shell Petroleum Co. Ltd.

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Shale-Oil Activities

by Russell J. Cameron* and Robert E. Gustafson*

Industry studies possibilities of atomic energy to reduce costs of mining and retorting. Research and pilot-plant work lags. Eastern Hemisphere commercial applications expand.

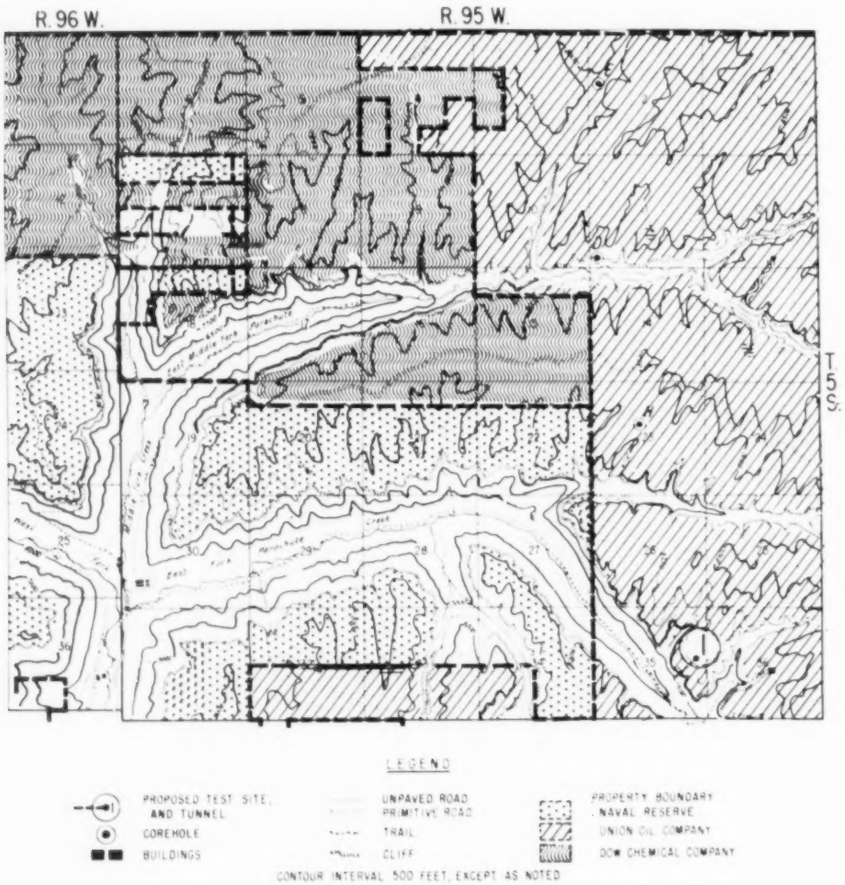
To those intrigued by the prospects of a domestic oil-shale industry and impatient for its realization, 1958 was a study in contrasts.

On the one hand, technologic progress appeared to lag at times as research scientists slowly and laboriously assembled a jigsaw of required fundamental knowledge and quietly released their findings piece by piece, and usually without interpretation.

At the other extreme, and seemingly just often enough to keep an ember of interest aglow, others announced a few headline-catching developments with more or less fanfare.

The latest significant event, fitting neither category precisely, became known late in December when oil-and-chemical-company executives found among their Christmas cards an invitation from the US Bureau of Mines and the Atomic Energy Commission to attend a conference considering a nuclear-test explosion in western Colorado's oil-shale beds. Proposed objectives and potential benefits of the experimental shot, as explained at Dallas, Texas, in early January, include shattering the shale and following that with retorting in place, thus eliminating in one stroke nearly 65% of shale oil's current production costs involved in shale mining and preparation. Possible added advantages are reduction of retorting costs, recovery of oil from shales too lean or too deep to mine and process by conventional methods, and solution of the spent-shale-disposal problem.

Topographic map of Parachute Creek area, Garfield County, Colorado, showing land ownership in vicinity of one proposed test site (circle, lower right) for a nuclear explosion on Naval Oil-Shale Reserves (Bureau of Mines map).



Other highlights of 1958: Union Oil Co. of California closed down its experimental mine and retorting plant near Grand Valley, Colo., for the announced purpose of digesting the data obtained after achieving successful operations in both. Coincident with the shutdown in late July, Union officials stated that shale oil now is competitive with the posted price of crude petroleum on the West Coast.

Denver Research Institute issued a summary report on its Aspeco process development work, sponsored by the Oil Shale Corp., of Beverly Hills, Calif. Costs of shale oil delivered to the West Coast were estimated to range from $1.42 to $1.92 a barrel. Next professed step, before attempting to finance a prototype plant, is to redesign the 24-ton-per-day pilot plant to improve mechanical features and insure continuous operation.

The Institute of Gas Technology, Chicago, Ill., announced the successful production of 800-Btu gas by hydrogenation of oil shale.

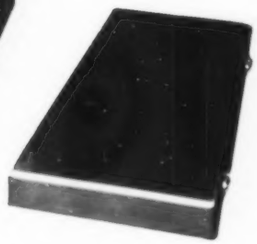
The Bureau of Mines reorganized and renamed its Laramie Petroleum Research Center, relieving its technical personnel of administrative duties to enable them to concentrate on a broadened program of basic research in both petroleum and oil shale. Its pilot plants at Rifle, Colo., remained inactive except for routine maintenance.

The Interior Department confirmed that oil-shale deposits in the north-central Piceance Creek basin, Rio Blanco County, Colorado, are richer and thicker than previously thought. A square-mile segment of the thickest beds contains a potential $2\frac{1}{4}$ billion barrels of oil.

Utah approved a form of lease agreement

* Cameron and Jones, Inc., Denver, Colo.

Fiberglass case (on all units) has integrally molded steel brackets which provide a means of attaching straps for portable use.



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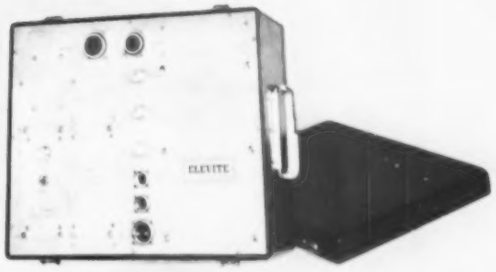

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MFM-1 MAGNETIC FIELD MONITOR
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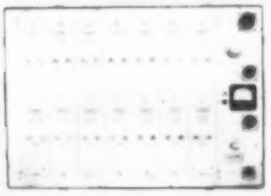

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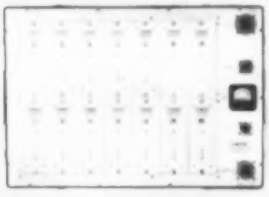

DM-2 FREQUENCY DEMODULATORS
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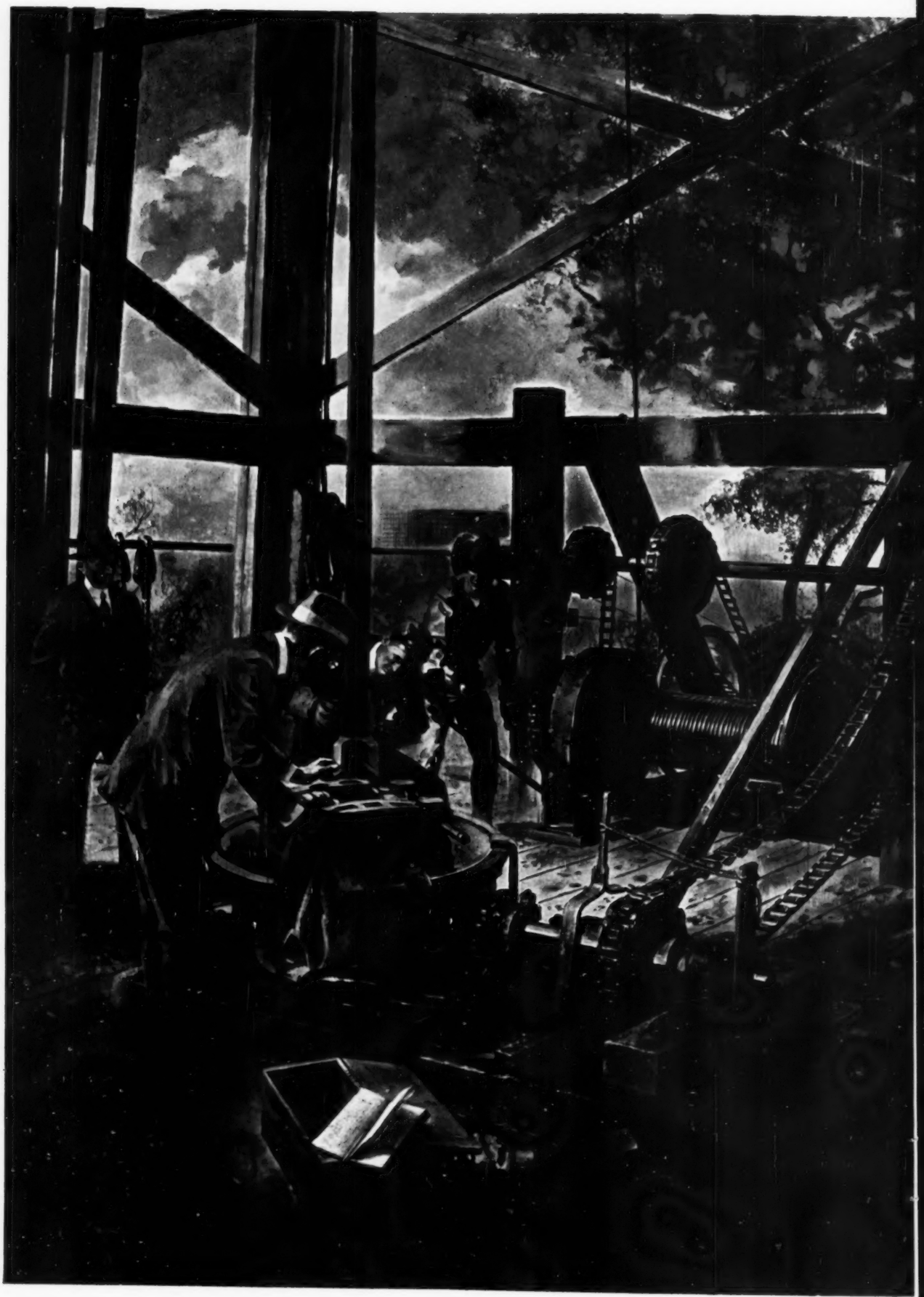

THE DAY AN INDUSTRY WAS BORN

THERE is no more historic day in the drilling industry than that day in 1909 at Goose Creek, Texas, when the first rotary rock bit was run under the watchful eyes of its inventor, Howard R. Hughes, Sr. For what happened that day revealed the real potential of the rotary system and marked the beginning of the rock bit industry.

Mr. Hughes—lawyer and mining engineer, turned drilling contractor—was no novice to rotary drilling. He had personally experienced the frustration of grinding away, days at a time, with fishtail bits without making measurable footage.

The bit he invented was the answer to drilling hard formations with the rotary. It introduced a new principle—conical cutters combining milled teeth that rolled on bottom with a chipping, crushing action and grooved gage surfaces that simultaneously cut the wall of the hole.

The footage drilled with Mr. Hughes' rolling cone bit exceeded, by far, anything that had ever been dreamed possible. Its success, and the success of the Hughes bits developed during the past fifty years, stemmed from a first-hand knowledge of the problems of the industry. Hughes engineers and field representatives today are men of long experience in the industry. Combined with their experience is another important ingredient—*research*—carried on continuously for a half century.

Through the years, Hughes has introduced virtually every major improvement that has been made in rock bits. But no single achievement has had greater impact on rotary drilling than that first rock bit run at Goose Creek in 1909.

In the painting at the left, the artist has re-created the scene of the running of the first rock bit. So important was secrecy that members of the drilling crew were ordered from the rig, and their places taken by Mr. Hughes and his three companions. Then, Mr. Hughes opened a padlocked wooden box, lifted out a burlap-wrapped bit, attached it to the end of the drillstem, and pulled the wrapping away as the bit was lowered into the hole. When it was safely out of sight, the crew was called back to resume drilling.

Enlarged color prints of this painting are available for the asking. Write: Advertising Dept., Hughes Tool Company, Box 2539, Houston, Texas.

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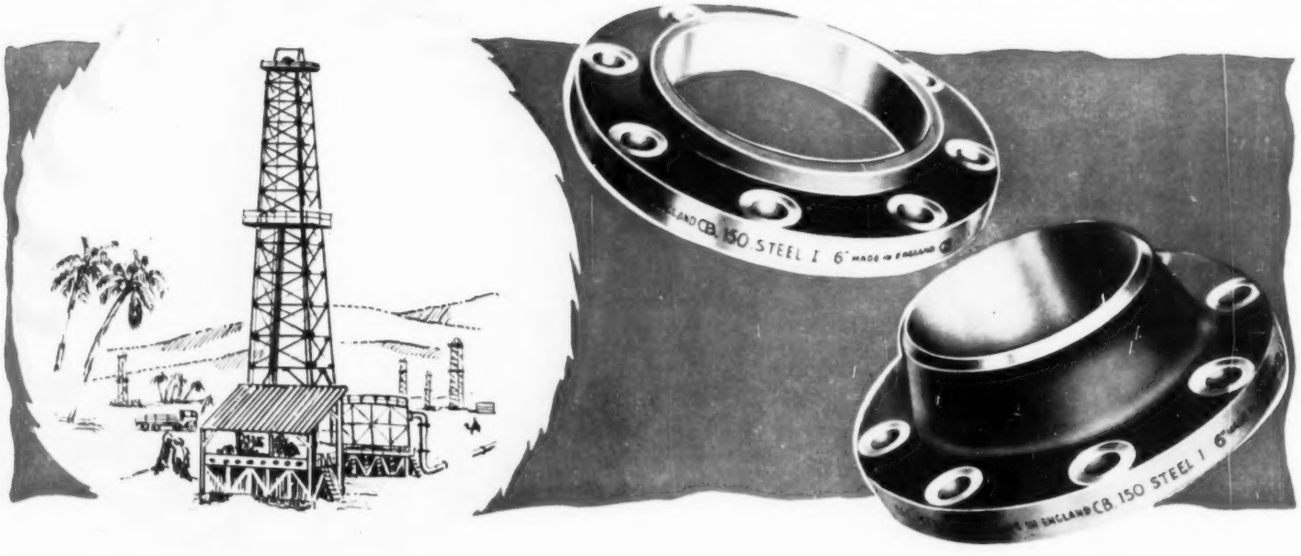

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and issued several leases on state-owned oil-shale lands.

The Texas Co. announced acquisition of a site in Salt Lake City for an oil-shale laboratory, but deferred construction.

Legislation to authorize a 27½% depletion allowance for shale oil identical to that enjoyed by petroleum was bypassed at the last congressional session. The current allowance is 15%, and is based on oil shale rather than shale oil.

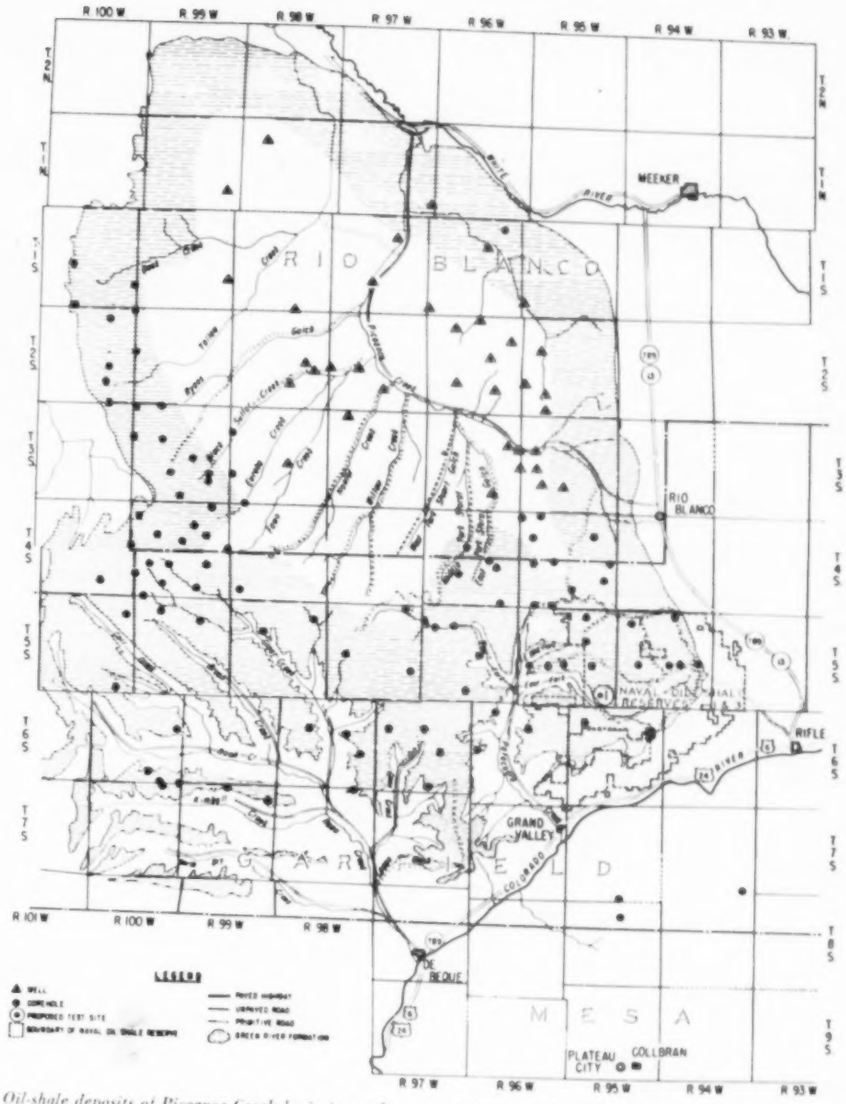
Major foreign developments in oil shale included: (1) *Brazil*—preliminary design work under way, on a prototype retort for Paraiba Valley shale; (2) *Russia*—construction in progress on a plant at Kochtla Jarwe, Estonia, to produce 10,000 b/d of shale oil for boiler fuel at a large power station; (3) *Sweden*—a 20% expansion in capacity is being made at the Swedish Oil Shale Co. plant near Kvarntorp, and research continues on *in situ* retorting with electrical heaters; and (4) *Thailand*—a joint Thai-Japanese plan to establish a shale industry in Thailand was announced, starting with a 6,000 b/d plant patterned after Japanese-built facilities in Manchuria.

"Plowshare" project: At the Dallas meeting, January 6 and 7, officials of the Bureau of Mines, AEC, and the University of California Radiation Laboratory briefed industrial representatives on the AEC's "Plowshare" project, designed to develop peaceful uses for nuclear explosives. Potential uses which have been cited, in addition to shale-oil production, include oil-field development, open-pit metal mining, power and isotope production, and harbor or other major excavation.

In soliciting cooperative funds to help finance a test explosion in oil shale, provided no belated international agreement precludes such experiments, government spokesmen said that the feasibility of underground atomic explosions was demonstrated by the Rainier experiment during Operation Plumbob in Nevada on September 19, 1957. In the Rainier shot, a 1.7-kiloton device was detonated 790 ft underground in a tunnel driven in volcanic tuff (which differs materially from oil shale).

Among the significant results and conclusions, following a post-shot examination of the test site, were: (a) Radioactivity can be completely contained in underground explosions, for virtually all fission products are trapped in a thin layer of insoluble fused rock. (b) Seismic effects are minor, and much larger devices can be fired safely without public annoyance. (c) The shot broke or crushed some 200,000 tons of permeable rock and 500,000 tons of relatively impermeable material. (d) Thermal energy still remaining in the rock 16 weeks after the test amounted to approximately one-half the total energy released by the device.

Government scientists, considering the application of nuclear explosives in producing shale oil, were interested particularly in the latter two results of the Ranier shot —breakage of great masses of rock and release of large quantities of heat. The rock-



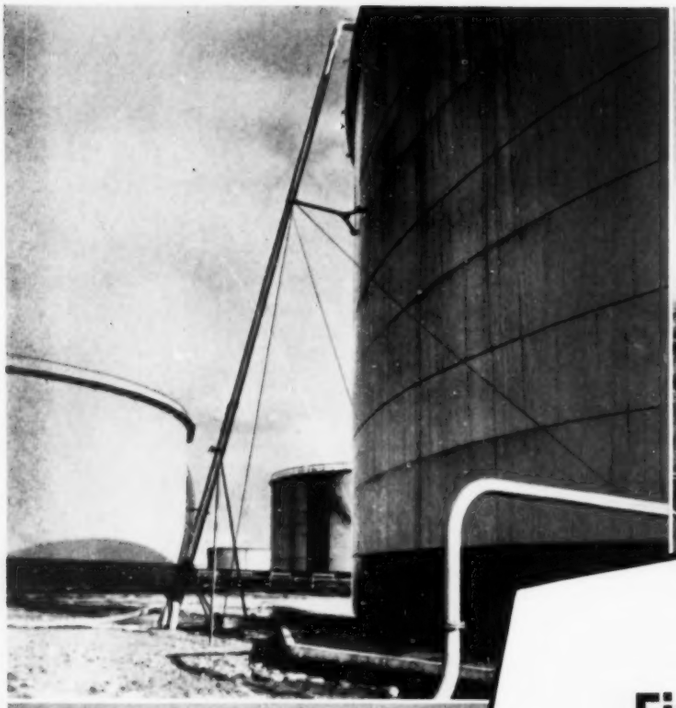
Oil-shale deposits of Piceance Creek basin in northwestern Colorado: Dots indicate where core holes have been drilled, and dots in triangles pinpoint exploratory oil and gas wells. Encircled figure 1 on Naval Oil Shale Reserves, lower right, is one potential site for nuclear test blast.

crushing effect may provide a means for preparing vast tonnages of shale for retorting by *in stiu* combustion, potentially a much cheaper way of producing shale oil than conventional aboveground processes.

In current practice, mining, shale preparation (crushing, grinding, screening), and retorting each requires a major capital investment and large operating costs. The Bureau of Mines estimates that mining contributes about 50% to the total cost of producing shale oil, shale preparation 15%, and retorting 35%.

If oil shale can be shattered by a nuclear explosion and retorted in place, long-standing economic barriers to utilization of the nation's vast oil-shale reserves may crumble. This technique could eliminate investment and operating costs for mining and shale preparation, and reduce those for retorting. An atomic explosion may, in effect, construct an underground retort, already charged with broken shale and ready to ignite. Initial fires set by the intense heat of the blast probably would have to be quenched to permit installation of oil-recovery facilities. The technique also may permit utilization of shales containing less than 25 gal of oil a ton, which now are considered too lean to mine and process economically. Further, it should effectively eliminate the problem of spent-shale disposal, which may be both troublesome and costly in a large operation, spent shale amounts to about 85% of the raw shale processed.

As government spokesmen pointed out, these potential benefits cannot be realized without some offsetting costs to be incurred in preparing sites for nuclear detonations, in fabricating and firing the device, and in post-shot exploration to determine results for use in planning an oil-recovery program. Producing oil from the broken shale by *in situ* combustion techniques also will involve costs which are comparable to those incurred in similar petroleum-recovery practices. Only by experiment can the



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402

feasibility and actual net cost reduction be determined for producing shale oil by this method.

Technicians of the Bureau of Mines have selected a potential site on the US Naval oil-shale reserve in northwestern Colorado. They and the Atomic Energy Commission are ready to proceed with plans for a test shot, which probably can be detonated in 1960 if industry financial support is promptly available. Costs of the experiment to industry are estimated at $1.2 million. The AEC would contribute a nuclear device and finance its own post-shot exploration.

Both the petroleum and chemical industries had indicated interest prior to the Dallas meeting, for they own or control large acreages of oil-shale land. More than 180 persons attended, proving that interest. As anticipated, however, no decision was reached, for the industrial representatives first must report back to their respective managements. The Bureau of Mines agreed to make formal written inquiry of each company represented as to its views on the (1) AEC-USBM proposed experiment and cooperative agreement as presented; (2) desirability of further research in an effort to answer some of the unknowns before incurring the expense of a nuclear shot; and (3) establishment of an industry advisory committee.

Union Oil program: The Union Oil Co. of California currently is analyzing data obtained from its $9 million semicommercial shale plant and mine near Grand Valley, Colo. Operations were suspended indefinitely late in July. Union's project included surface and underground mining, operation to prove its retort, and development of refining methods.

The original mine was an open quarry intended primarily to supply shale to the retort, via an aerial tram, rather than to test or develop mining methods. An underground mine was developed later to supplement shale supplies and provide first-hand information and cost data on the room-and-pillar method. Problems were encountered, however. First attempts to drive horizontal adits from the oil-shale outcrop were defeated by poor ground conditions. Shifting to another site provided better ground, and successful access was obtained by heavily reinforcing the portal and entry. After the first 100 ft to 150 ft, rock conditions improved considerably. The roof was bolted after every 15-ft advance and it held reasonably well, although there was some sloughing because of a general parting 8 in. above the roof plane.

The success, although achieved with difficulty, increases confidence in this mining method, which was used by the US Bureau of Mines in its oil-shale mine near Rifle, Colo.

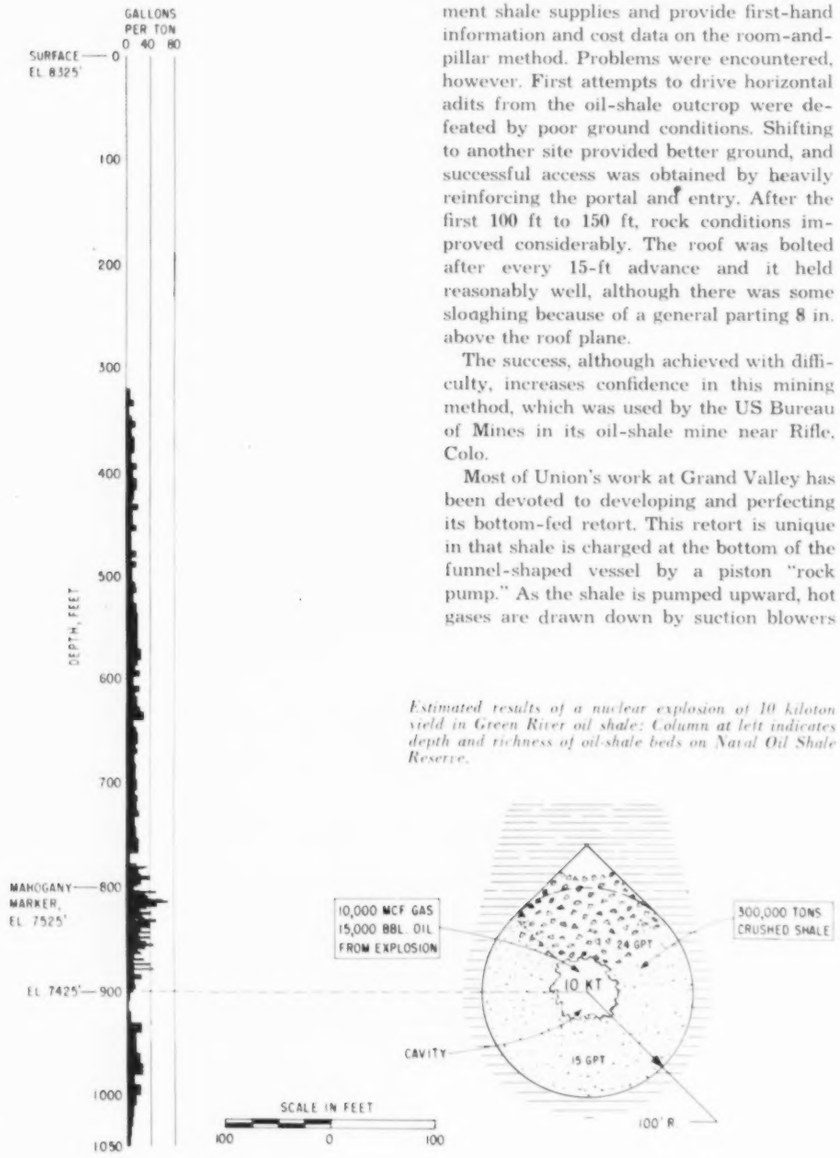
Most of Union's work at Grand Valley has been devoted to developing and perfecting its bottom-fed retort. This retort is unique in that shale is charged at the bottom of the funnel-shaped vessel by a piston "rock pump." As the shale is pumped upward, hot gases are drawn down by suction blowers to retort the shale and convert the organic kerogen to oil. These hot gases come from a combustion zone higher in the vessel where residual carbon is burned. Spent shale spills out at the top. In the original design, slowly rotating spiral plows with liquid sodium cores were provided at the top of the retort to prevent clinkering. Later, when it was found that clinkering was not a problem, the plows were replaced with a simple rotating scraper which moved burned shale to the discharge weir. The combustion and retorting zone was relocated from the center section of the retort to within a few inches of the top, providing greater cross-sectional area and a substantial increase in throughput rates.

The retort at Grand Valley was first operated in March 1957. It is about 40 ft high, and originally was designed to have a throughput rate of 360 t/d. Before shutdown in July 1958, it was announced that rates up to 1,200 t/d had been attained during continuous runs of six weeks.

Retorting costs have been correspondingly improved by the higher throughput. Union's original objective was to confirm that retorting costs would approximate $1 per barrel. It now finds they are substantially under that. Current thinking is in terms of 50 cents per barrel.

Union's research in upgrading shale oil so that it is comparable to high-quality petroleum crudes has been rewarding. The oil, as obtained from the retort, is highly viscous, and has a pour point of 90 F. At room temperature, it is a slushy solid. It also is heavy in nitrogen, about 1.8%. Union found that coking reduced the pour point to 30 F, and its "Unifining" method of hydrogenation removed the nitrogen. This semi-refined shale oil then can be refined further by conventional methods. As shown in Tables 1 and 2, jet and diesel fuels meet exacting military specifications. If gasoline is desired, the oil can be catalytically cracked or reformed to yield a large percentage of 100-octane stock. Union also has found that electrode-grade coke for the aluminum industry can be obtained by delayed coking.

Aspeco process: The Aspeco process of Swedish origin is being investigated by the Denver Research Institute, University of Denver, for the Oil Shale Corp., which holds Western Hemisphere rights. Retorting is



Estimated results of a nuclear explosion of 10 kiloton yield in Green River oil shale; Column at left indicates depth and richness of oil-shale beds on Naval Oil Shale Reserve.

Table 1—Military JP-4 Jet Fuel

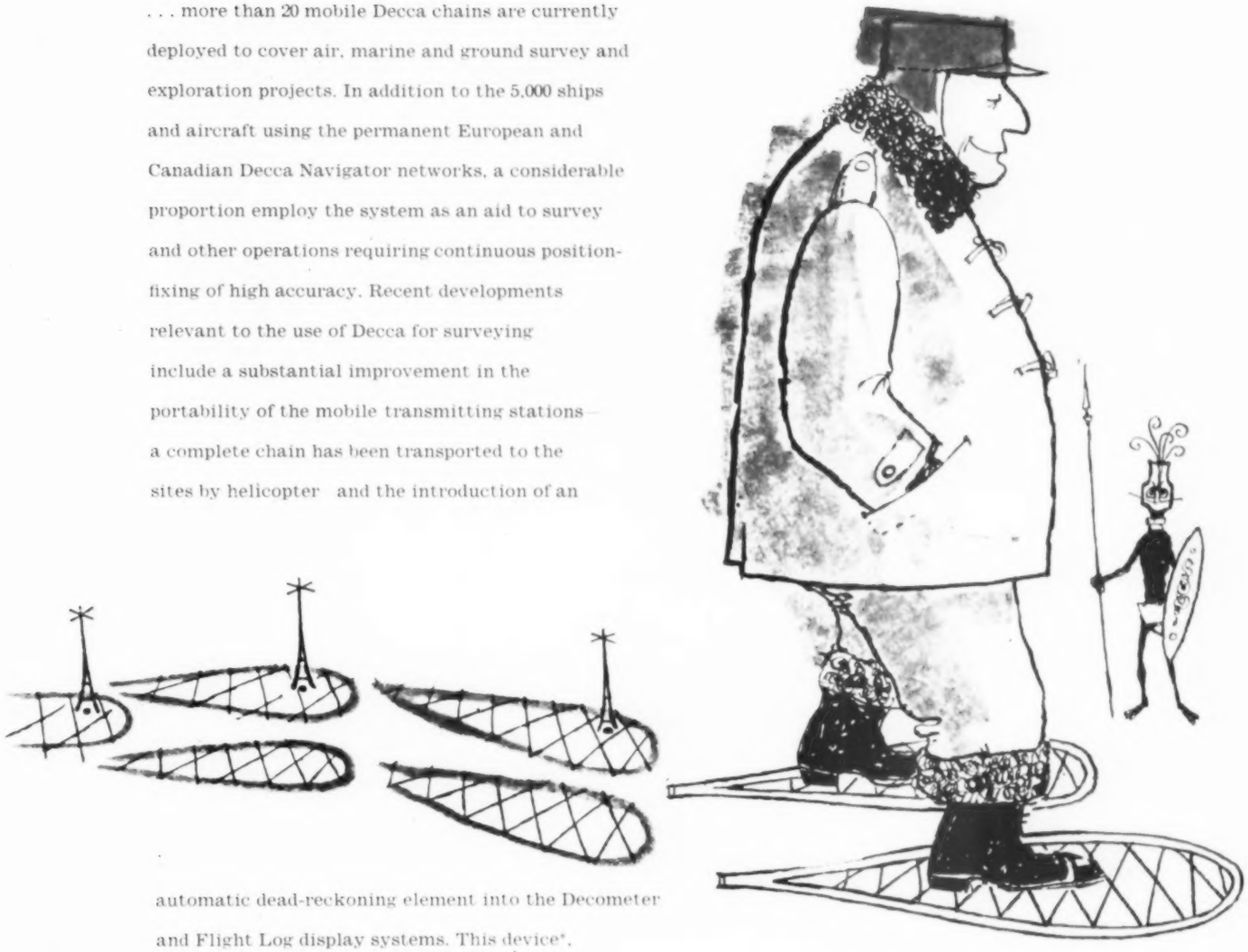
Characteristics	Military Specification	Shale-derived Jet Fuel
Aromatics, % by volume	25 max.	17
Freezing point, deg F	—76 max.	—78
Heat of combustion, Btu per lb	18,400 min.	18,634
Sulfur, mercaptan, % by weight	0.005 max.	0.0002
Sulfur, total, % by weight	0.4 max.	0.01
Nitrogen, total	—	0.05
CFR coker merit rating	—	72

Table 2—Military Marine Diesel Fuel

Characteristics	Military Specification	Shale-derived Diesel Fuel
Cetane number	47 min.	55.2
Pour point, deg F	0 max.	0
Cloud point, deg F	10 max.	—4
Kinematic viscosity, CS @ 100 F	2.1-6.0	2.3
Sulfur, % by weight	1.0 max.	0.01
Corrosion	No. 1 ASTM max.	1

FROM NEWFOUNDLAND TO NEW GUINEA

. . . more than 20 mobile Decca chains are currently deployed to cover air, marine and ground survey and exploration projects. In addition to the 5,000 ships and aircraft using the permanent European and Canadian Decca Navigator networks, a considerable proportion employ the system as an aid to survey and other operations requiring continuous position-fixing of high accuracy. Recent developments relevant to the use of Decca for surveying include a substantial improvement in the portability of the mobile transmitting stations—a complete chain has been transported to the sites by helicopter and the introduction of an



automatic dead-reckoning element into the Decometer and Flight Log display systems. This device*, already used with marked success in two airborne geophysical surveys, eliminates the need for manipulation of the airborne receiver while in flight and the attendant risk of lane error; it also considerably increases the service-area of low-power transmitting stations under the radio noise-level conditions encountered in the tropics.

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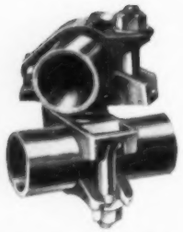

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accomplished in a rotary kiln by solid-to-solid heat transfer effected by bringing heated metal or ceramic balls into contact with crushed shale (see *World Petroleum*, September 1958, p. 90).

DRI has operated a pilot plant at Denver using shale from western Colorado. Data collected prior to mid-1958 were used in preparing a summary economic report that estimates costs for shale oil delivered to California at $1.42 to $1.92 per barrel, depending upon the quality of shale used and the depreciation rate assumed. These costs, lower than any previously claimed, are exclusive of profits, interest on capital, federal income taxes, royalties, or credit for depletion allowance.

Capital requirements for a 19,200 t/d plant in western Colorado are estimated by DRI at $23 million. It would produce between 11,400 b/d and 13,700 b/d of oil, depending upon whether 25- or 30-gal-per-ton shale is used.

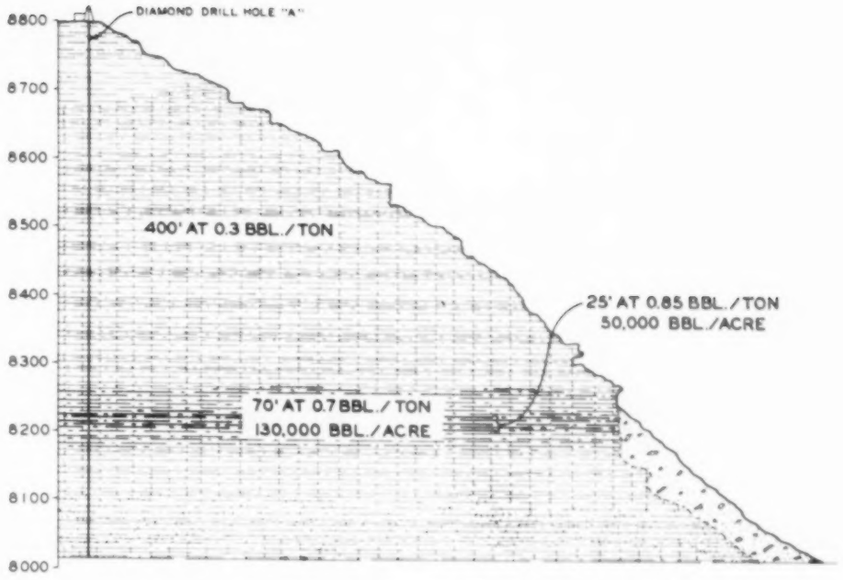
Cost estimates for retorting were based on pilot-plant work. Those for other operations—ball heating, fluidization, refining, and pipelining—were developed in consultation with various companies.

DRI plans to continue pilot-plant tests after modifying the equipment. Several processing steps have yet to be tested, including operation as an integrated unit in which the balls are reheated by spent-shale combustion. Ultimately it is proposed to build a 1,200 t/d to 2,400 t/d prototype or semicommercial-scale unit.

During 1958, DRI sought contributions from industrial sponsors to establish an oil-shale foundation to underwrite a program of fundamental research on oil shale. Some support was obtained, but more is needed to warrant undertaking the projected three-year program. A prospectus listed research objectives as the (a) complete characterization of the organic matter in oil shale, its molecular structure, and chemical composition; (b) physical and chemical relationships of the organic and inorganic portion of the oil shale; (c) physical and chemical mechanisms of the decomposition of the organic complex, particularly under the action of heat or pyrolysis; and (d) such related chemical and physical phenomena as may be pertinent to the above.

Fuel gas from oil shale: As part of a program seeking substitutes for natural gas, the Institute of Gas Technology, at Chicago, conducted batch experiments on dry high-pressure hydrogenolysis (hydrogasification) of oil shale.

Shale assaying 22.9 gal of oil per ton and up to 5-mesh in size was used in a one-liter autoclave. Temperatures up to 1,300 F, and pressures ranging from 1,200 to 5,700 psig, were employed. A gas rich in methane and ethane was obtained, with a heating value of more than 800 Btu per standard cubic foot. Conversion of organic carbon varied from 90% to 100%, depending upon the pressure. IGT pointed out, however, that increases in conversion above 2,000 to 2,500 psig were inadequate to warrant higher pressures in any commercial application.



Section of uppermost oil-shale measure on Naval Oil Shale Reserves shows thicknesses and oil content of various beds (Bureau of Mines).

Varying the size of shale particles had no significant effect upon rates and yields.

No further batch testing is anticipated; but the Institute is designing a continuous reactor, and hopes to build and test it if adequate funds become available.

The initial experiments aroused speculation that oil shale can be used as a source of raw material for ethane-based chemical processes, provided proper control of conditions will yield a gas containing more ethane and less methane.

Commercial production of fuel gas from oil shale ultimately may become attractive because of the higher conversion of organic matter into useable product. In conventional retorting, only about 80% of the total organics are recovered as oil and gas. Shale appears easier to hydrogenate than coal because of its more reactive nature and its more favorable carbon-hydrogen ratio.

Bureau of Mines activities: A reorganization in December changed the name of the Bureau of Mines station on the University of Wyoming campus to the Laramie Petroleum Research Center, and placed H. M. Thorne in charge as research director. The major objective, bureau officials explained, is to relieve technical staff members of as much administrative detail as possible and permit them to devote more time to a broadened program of research, thus obtaining better use of scientifically-trained manpower.

H. M. Thorne succeeds H. P. Rue who recently retired. John S. Ball and W. I. R. Murphy will continue as Dr. Thorne's principal aides. Mr. Ball coordinating petroleum research and Mr. Murphy oil-shale research. H. N. (Jack) Smith was appointed superintendent of the research center, and will serve as Dr. Thorne's principal assistant in the administrative field, taking over the technical and mechanical supporting services, together with finance, property, and personnel responsibilities.

The 1958 program at Laramie emphasized fundamental research, and included projects on oil shale's physical and chemical properties, fermentation of oil shale, shale attack by atomic hydrogen, and radioactive tracer studies on the decomposition of shale-oil products. Results are presented before the technical societies and published in the journals or under the bureau's format as soon as available.

Laramie personnel will direct Bureau of Mines activities associated with the AEC's "Plowshare" project, if a nuclear test explosion is detonated in oil shale.

The pilot plants at Rifle, Colo., inactive in 1958 except for maintenance duties performed by a small crew, remain under the supervision of Mr. Thorne at Laramie, following the reorganization. Housing, shops, and some of the equipment at Rifle would prove useful in preparing for a "Plowshare" project. Thus, no action has been taken on various proposals to lease or otherwise dispose of the plant.

The Department of the Navy, intent on leasing the facilities to private industry, has attempted to regain control of the Rifle installation, which is on the Naval Oil-Shale Reserves. Legislation to effect this transfer must be passed by Congress. The Navy desired that a lessee complete the evaluation of the gas-combustion retort, developed by the Bureau of Mines, but incompletely tested before funds for the Rifle plant were cut off.

Oil-shale reserves: Analyses by the Bureau of Mines of drill cuttings obtained from companies sinking 11 oil and gas wells in the Piceance Creek basin disclosed that

(*Continued on page 96*)

New tools for the geophysicist

Completely transistorized seismographs have reduced weight and bulk of equipment, facilitating operations in difficult and remote terrain. Drive to reduce costs finds expression in many ways.

THE great growth in exploration activity outside the United States during the past two or three years has created problems for the geophysicist which now are being met to an increasing degree by manufacturers of specialized equipment. Much of the area being studied today is difficult of access for both personnel and equipment. Result is that the bulk and weight of equipment have become critical factors.

Elsewhere in this issue are two special articles which illustrate this situation. Hugh Harvey, of Shell Oil Co., has written about the problems of reconnaissance in the far north in Canada; and Frederick L. Schenck, of McCullough-Ray, has given fascinating sidelights on the logistics of operations in Libya.

Responding to the demands of the world wide exploration drive, manufacturers of geophysical equipment have turned to miniaturization techniques. Most important of these has been the adoption of transistors and silicon diodes and rectifiers in field recording equipment. Printed circuits have been employed to further simplify and lighten equipment. Through the use of semiconductors for circuit amplifying and control elements, it has been possible to pack a 24-channel seismograph in a single case weighing less than 60 lb.

Employment of semiconductors to replace vacuum tubes has reduced power requirements also. A 12-volt aircraft battery with transistorized regulators can be packaged in a unit to weigh only about 45 lb. Since the transistorized seismograph pulls only about nine amperes, the single-battery unit can be used for an extended period.

With the two-case system, the number of bearers in the field is limited and light helicopters can be used, thus reducing reconnaissance costs. The reduction in size and weight has not been accomplished at the expense of efficiency.

Application of helicopters to seismic surveying was broadened during the past year when one company mounted complete instrumentation, plus a photographic dark room, in a single "whirlybird." With this equipment, instruments can be moved from shot point to shot point, in jungle or muskeg, with minimum delay.

A single prism stereoscope for field use has been built which weighs only 2 lb and can be carried folded into a handy fabric case.

Even housing for the field party now can be carried in by helicopter. A manufacturer of specialized equipment for the U.S. Air Force has developed inflatable "geodomes" of plastic and fabric which may be folded into a small compass, carried to location, and set up with a small air pump. The houses have a high degree of insulating value so that they make comfortable quarters in sub-zero or high-temperature areas.

Speed in the field is being improved by the development of rugged geophones. Cable geophones have been gimballed so that they can be permanently attached to the spread cables for ease in reel or squirter applications.

To increase shot-hole drilling speed in hard formations, one manufacturer has added a fourth blade to his insert bits. Blades are removable, permitting the use of an extended series as they become worn, without changing the bit body.

Explosive costs have been cut as much as 50% through the use of ammonium-nitrate prills as a blasting agent. Field tests have shown that the fertilizer is just as satisfactory, pound for pound, as a source of seismic energy as dynamite.

In a paper presented before the recent annual meeting of the Society of Exploration Geophysicists, T. O. Hall and Jack Martin, of General Geophysical Co., reported on their experience with the cheaper explosive. They found that better records were obtained than with dynamite, and attributed this to the packing of the hole when ammonium nitrate was used, thus concentrating the charge at the bottom. Tamping is necessary to obtain a satisfactory explosion in the case of the ammonium nitrate, since both confinement and high temperatures are necessary for detonation.

Safety precautions are fewer than in the case of dynamite. Ammonium nitrate should be stored in a well ventilated building and in small stacks. Burning creates poison gases, so fire fighting must be done from a distance. Drenching with water is the only effective way to fight a fire. Ammonium nitrate is not highly flammable, but will burn; and combustion gases must not be confined if an explosion is to be avoided. The prills should not be contaminated with unknown materials not recommended by the manufacturer.

Handling methods are simple, Messrs. Hall and Martin reported. "Since ammonium nitrate is water-soluble, it never should be loaded unconfined into a hole in which water is standing; it may be loaded into damp holes if the charge is to be shot promptly—within two or three hours; it may be used for immediate shooting or as a sleeper charge in dry holes.

"By itself or with dry additives, ammonium nitrate is a low-value explosive, with a decomposition rate of approximately 2,000 meters per second. This rate can be increased to 4,000 meters per second by the use of the proper quantity of diesel-fuel additive. The optimum quantity of fuel oil is 5% to 6.5% by weight of fuel oil, calculated on the weight of the prilled ammonium nitrate. The use of one gallon of fuel oil per 80 lb to 100 lb of prills gives a very satisfactory ratio. It should be pointed out that the use of too much fuel oil with ammonium-nitrate prills has a damping effect which definitely reduces efficiency.

"The decomposition or detonation rate of fuel-soaked ammonium-nitrate prills is increased by close contact with a high-velocity primer. This property of an explosive known as 'overdrive,' causes the slower-detonating explosive to detonate at

a velocity approximating that of the faster-detonating primer. The greater the percentage of the low-velocity explosive in close contact with the high-velocity explosive, the greater the rate of detonation of the former. Utilization of this 'overdrive' property makes it possible to obtain detonation velocities in excess of 6000 meters per second for ammonium nitrate.

"It is possible to determine quite precisely how much primer must be used to secure optimum detonation of a given quantity of oil-soaked ammonium-nitrate prills. In actual practice, it has been found that, in the 4-in. to 4.75-in. holes common to seismic work, a one-pound dynamite primer is satisfactory for charges up to 20 lb of prills, and a 2.5-lb primer is satisfactory for 20 lb to 40 lb of prills."

The authors reported savings of about $550 per week by using prills which cost less than one-fourth as much as dynamite. Mixing prills with oil does not delay operations. Small charges may be unsatisfactory in some areas, so the authors suggest that the minimum charge be experimentally determined in each new area.

Improvement of office equipment has not been overlooked during the past year. Two developments of Sinclair Research Laboratories have been put into commercial production. The Seismod is an alternate presentation method which combines advantages of variable density and variable area presentations while retaining subtle amplitude variations. The second Sinclair innovation is a dip plotter which automatically plots depth points 10 times as fast as the job can be done by hand.

An aid in seeking stratigraphic traps is the Simulated Reflection Analog, named "Siran," which simulates a seismic reflection trace from geological or geological and geophysical data.

A patent was issued last December to Louis R. Padberg, Jr., covering his method of subsurface exploration by sonic means which was described in WORLD PETROLEUM in March 1958, p. 60-63. Work is continuing on the under-water spark and on the high-level low-frequency sound source proposed as a replacement for explosives in seismic work.

In this connection, it is interesting to note that technologists in the USSR are experimenting with spark emanations and with repetitive explosions of small magnitude for bore-hole drilling.

The Marine Sonoprobe developed by Socony was improved during the past year by application of new recording techniques.

Because of the vast amount of seismic data which requires processing under today's worldwide scope of operations, the industry is constantly seeking methods of reducing machine time in central-office data reduction and analysis. Preprogramming static corrections has been one approach to this problem.

In the following pages will be found brief reports on many of the new tools offered on a commercial basis to the oil geophysicist during the past year. END

Economical magnetic tape processing

by J. M. Cunningham*

Magnetic reproducer includes facility for preprogramming static corrections to cut processing time; transistorized field system housed in single case features portability and ease of installation.

MAGNETIC recording playback centers throughout the world are under contant pressure to process seismic records faster, more economically, and with greater versatility. This is due to the ever-increasing quantity of magnetic recordings now being produced, and also to the current trend toward more complex processing techniques providing data in a form more nearly complete and ready for interpretation. As a result, a critical need has existed for improved magnetic-recording instruments with greater flexibility and requiring less setup and processing time per record. Toward this end, Techno Instrument, during 1958, designed and introduced the TI-580B Automatic Time Corrector.

The new machine is designed for installation on a Techno TI-401 Type Recorder and has the following features:

1. Dynamic correction for normal moveout to match any spread configuration or detector placement. Changes in setup are made by simple adjustment, without interchange of fixtures or cam sets.

2. Convenient adjustment for inter-record spread-length changes.

3. Static correction for weathering and elevation: Settings can be made for each channel individually, or multi-channel data can be preprogrammed in card form for application in one fast operation. In either case, the resulting correction pattern is indicated visibly for inspection.

4. Simple averaging adjustment for situations where a linear distribution of static correction is required.

5. Corrected playback of all data, timing and auxiliary channels on a simultaneous basis during a single drum revolution.

The new machine, shown in Fig. 1, operates on a straightforward mechanical principle, and can best be described by a separate discussion of each function.

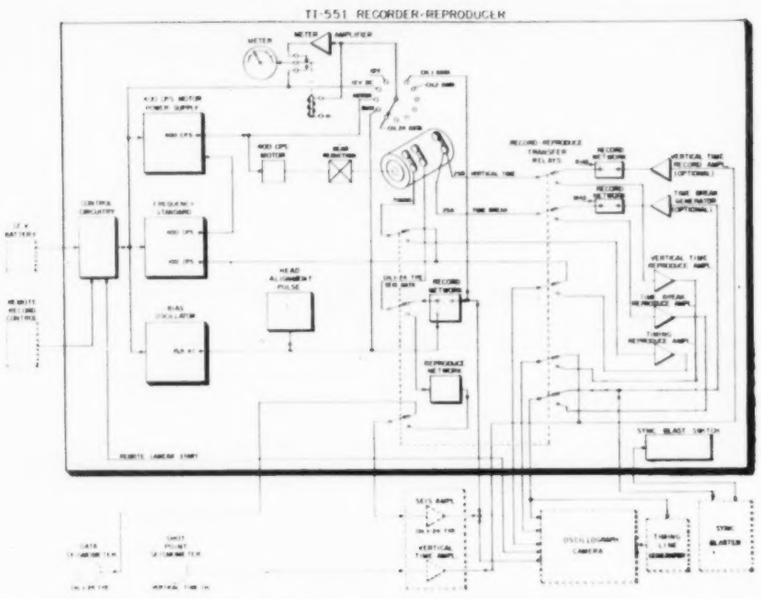
Dynamic Section: Up to 150 milliseconds of dynamic correction may be applied to any data channel by means of a proportioning mechanism consisting of a pair of rotating drive plates and individual adjustable follower assemblies. Movement from each follower is coupled to one input of a differential, the output of which positions an associated magnetic head. The followers are calibrated in percentage, and are used to set the moveout correction to match the recorded spread configuration. All channels will handle correction rates up to 500 milliseconds per second.

Velocity data are fed to the dynamic section of the machine from a cam which has been cut in accordance with a simple plot or chart of "record time" and the far channel moveout correction required at that time. The cam has an infinite number of data points over the 150-0 millisecond range. Cams can be stored indefinitely and used for other record areas with similar velocity characteristics. The cam is driven from the reproducer drum shaft through a calibrated phasing device which orients it with respect to the recorded information on the field tape. Techno offers a 24-hour cam-cutting service, but can also furnish a specially developed cam cutter for customer use when operating in remote areas.

Dual spread-length adjustments control

Recorder Reproducer System.

*Manager, Techno Instrument Co., Los Angeles



Recorder Reproducer Functional Block Diagram.

the degree of movement of each dynamic correction drive plate with respect to data from the velocity function cam. These adjustments provide a fast and convenient means of setting the machine to match various symmetrical and asymmetrical split spread configurations.

Static Section: Static corrections for weathering and elevation can be made for each channel individually, or multi-channel data can be preprogrammed in card form for fast application in one operation. For individual corrections, each channel is equipped with a simple lever-arm type adjustment, covering a range of 50 milliseconds. Movement produced by the arms is coupled to the second input of the differential associated with each magnetic head; thus the dynamic and static functions of the machine are completely independent. Clearly engraved index marks representing 1 millisecond increments are approximately 1 16 of an inch apart, and appear on a curved plate on the front panel of the machine.

To reduce setup time in the playback center, all data channel static adjustments can be made by inserting a prepunched "Staticard." A control surface for each static adjustment arm contacts the Staticard, and is positioned in accordance with the information preprogrammed for that channel. Individual channels may be readjusted manually if required. Regardless of whether the static adjustments are made manually or with the Staticard, the overall pattern of weathering and elevation correction is visibly indicated by the relative position of the static adjust arms. A clearing bar, located on the front panel, is used to clear previous settings. It can also be used to set simultaneously all data channel static adjustments to the zero position. The Staticards are approximately 2 in. wide and 6 in. long for a 24-channel machine, and are fabricated of thin aluminum cards are flat, and can be stored with each magnetic tape for filing until required in the playback center.

A semi-automatic punching device to prepare Staticards has been designed. A clearly calibrated dial is used to set the static adjustment to be punched for each channel. Once set, the punch is actuated by a remote-controlled solenoid, and the Staticard is automatically indexed to the next channel position. The punch is arranged for future tie-in with automatic static or first-arrival plotting systems. A 24-channel card can be punched in 30 sec to 45 sec, and the overall static adjustment accuracy is within one millisecond. Cards can be prepared in advance by clerical personnel, thus freeing skilled technicians for other operations.

An averaging adjustment is included to correct for a linear distribution of weathering and elevation across the spread. This is accomplished by tilting the two moveout drive plates in accordance with the setting of calibrated dials associated with the first and last data channel positions. This method is much faster and more accurate for such a purpose than making individual channel static adjustments.

The Staticard feature, coupled with the ability to process all channels simultaneously during a single drum rotation, makes the TI-580B Automatic Time Corrector an ideal magnetic reproducer for use in playback processing centers.

Field System: To provide a moderate-cost versatile field recording system which could be combined readily with conventional equipments, Techno developed the new TI-551 Recorder-Reproducer. This compact single unit, shown in Fig. 2, weighs only 60 lb, yet includes 24 data-channel magnetic recording and playback circuits, amplifiers for timing and auxiliary channels, timing systems, power and bias supplies, and complete signal circuit switching for the combined installation. The unit is completely transistorized, and uses rugged printed circuit boards throughout. A functional block diagram of the system is shown in Fig. 3.

Data Channels: 24 seismometer circuits are routed through a pair of input connectors to the internal relay switching system. During the record function, the seismometer circuits are switched through the TI-551 to the seismic amplifiers. The output signals from these amplifiers feed a group of recording networks within the magnetic recorder. At this point, high-frequency bias voltage from a self-contained transistorized bias oscillator is mixed with the signals to be recorded. These signals are then fed to the data-channel magnetic heads.

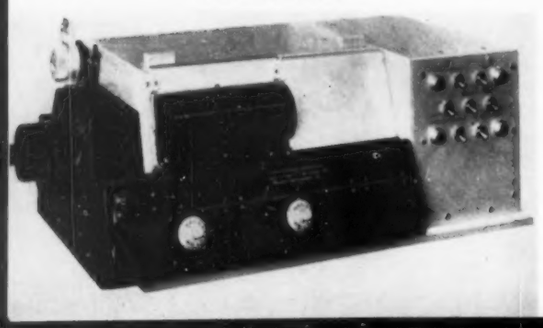
During playback, the magnetic heads are switched to a bank of frequency and phase-correcting networks and then to the seismic amplifier input circuits. The switching relays and other internal circuits are automatically controlled by the record or playback function switches on the front panel of the recorder-reproducer.

Timing System: During record, the signal from an internal 400-cycle precision fork is scaled down to 100 cycles and fed to the timing channel magnetic head. This timing signal is also fed to an external camera circuit. During playback, the timing head is switched to a transistorized playback amplifier, the output of which is fed to the external camera circuit. During both operations, the 400-cycle signal is amplified by a transistorized power supply and is used to drive the recorder-reproducer drum by means of a 400-cycle hysteresis synchronous motor and a precision gear train. Drum rotation is stabilized within 0.3 sec after the record circuit is energized.

Auxiliary Circuits: Two auxiliary circuits are provided for processing time break and vertical time signals. During record, these signals are routed through optional transistorized recording units to networks and to a dual-channel magnetic head. For playback, each auxiliary head circuit is switched through individual transistorized amplifiers to a receptacle for external connection to a camera or associated equipment.

(Continued on page 83)

Automatic Time Corrector Installed on Recorder Reproducer.



Behind the Record...
To produce this seismic record . . .
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A set of precision microswitches is arranged to energize a head alignment pulse circuit, and to synchronize the shot with respect to drum rotation. An additional circuit is provided which can be used to operate a presuppression circuit or other special functions as required. Also included is a metering circuit for use in checking and setting recording levels and important operating voltages within the system. The record and the reproducer functions are isolated by an interlock system to eliminate operational errors.

The system is complete within a single package, and does not require external switching or control components. Power consumption during operation is approximately 10 amperes at 12 volts DC. Warmup time prior to initiating a recording operation is less than 3 sec. The system can be carried into difficult operating areas or mounted in a seismic recording truck.

END

A 4-blade insert bit has been developed for faster penetration in harder formations by Herb J. Hawthorne Inc., Houston. More cutting surface on bottom keeps the bit from walking, in hard rock, for straighter hole to load without loss of gauge and with less strain on the drill. It may be used in air or water drilling.

The 4-blade unit, with a 4-blade shank, is interchangeable with the 3-blade units, in the same type "Blue Demon" bit body. Alloy bar flats, to speed breakout, are welded to the precision-machined heat-treated steel bodies, available for box-or-pin connection. The tough forged-tool steel blades with high-quality tungsten-carbide inserts, welded by special process to cutting surfaces, are replaceable on the drill . . . permitting the use of many sets with a single bit body.

A unique grinding procedure on the blades produces the superior cutting edge, which permits faster rotation on bottom . . . for more efficient drilling, at lower cost per foot of hole.

Siran for Trap Studies

Equipment for studying the potential effectiveness of the reflected method in prospecting for stratigraphic traps has been perfected by Seismograph Service Corp., whose technical staff has been deeply engaged in studies of possible geophysical methods of finding traps. The equipment has been named "Siran," a word derived from Simulated Reflection Analog.

The device is built to fill the need to synthesize a seismic-reflection-type trace from geological, or geophysical and geological, data. This need stems from the fact that the seismologist often has geological or geophysical data such as velocity logs, etc., which suggest likely seismic-reflecting horizons in the subsurface. The physical factors believed responsible for these horizons can be suitably programmed into the Siran. This is done by a control mechanism which regulates its function generator whose output is displayed as an amplitude trace which may be magnetically stored.

The machine is so designed that a study can be made of the effects of: (1) shot pulse width; (2) shot cavity resonance; (3) earth transmission filtering; (4) geophone plant effects; (5) geophone simulation; (6) seismic amplification; and (7) galvanometer simulation. In addition to being able to study these effects, the operator simulates seismic-reflection traces by programming into the Siran the physical properties responsible for reflections. These properties are depth, velocity, and density.

The display section allows the operator to view two traces simultaneously so as to permit comparison between two outputs from the Siran—one from storage, and the other one being programmed to simulate geological and geophysical conditions. The display section is equipped with a Polaroid camera to photograph the oscilloscope traces and make a permanent recording.

The signal generator may be programmed to simulate stratigraphic sections and the character of the seismic record expected from them. Thus the Siran is valuable for studying the potential effectiveness of the reflection method in prospecting for stratigraphic traps.

Gimbaled Cable Geophone

Electro-Technical Labs, Houston, has developed a light-weight rugged high-output waterproof gimbaled cable geophone, designed to reduce time required for layout and pickup of pattern detectors. The Ev-9 may be attached permanently to the spread cable. It is said to be easily handled with cable reels or cable squirters.

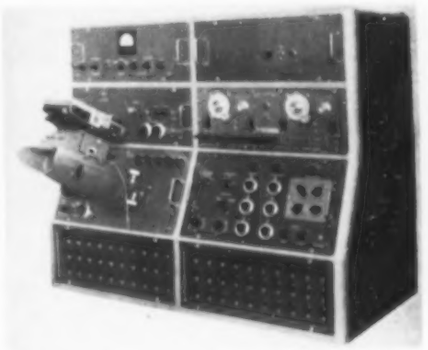
Transistorized Seismic Amplifier System

Texas Instruments Inc. last October announced its first all-transistorized seismic amplifier system. Weight, power, and size savings over conventional vacuum-tube systems range from 50% to 80%. This new system, called the "Explorer," model 8000 Seismograph, is a 24-channel seismograph, complete with control and test circuitry, contained in one portable waterproof case weighing only 57 lb. Power for the system is supplied by an all-transistorized regulated power supply and a light-weight 12-volt aircraft battery, both occupying another portable case weighing only 45 lb.

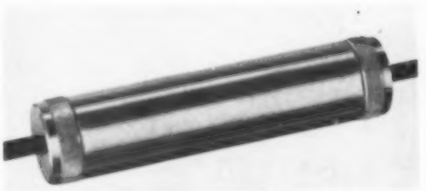
Conventional 24-channel portable amplifier systems occupy three to six cases. Thus, in areas where maximum portability is essential, the two-case "Explorer" greatly reduces exploration costs through a simple reduction in the manpower needed to transport the system. In truck operations, the compactness and low power requirements permit use of a substantially smaller recording truck.

Reliability is insured by printed circuit construction and the exclusive use of semiconductors as circuit amplifying and control elements. The "Explorer" employs 591 germanium transistors and 103 silicon diodes and rectifiers manufactured by the

Hawthorne "Blue Demon" 4-Blade Insert Bit.

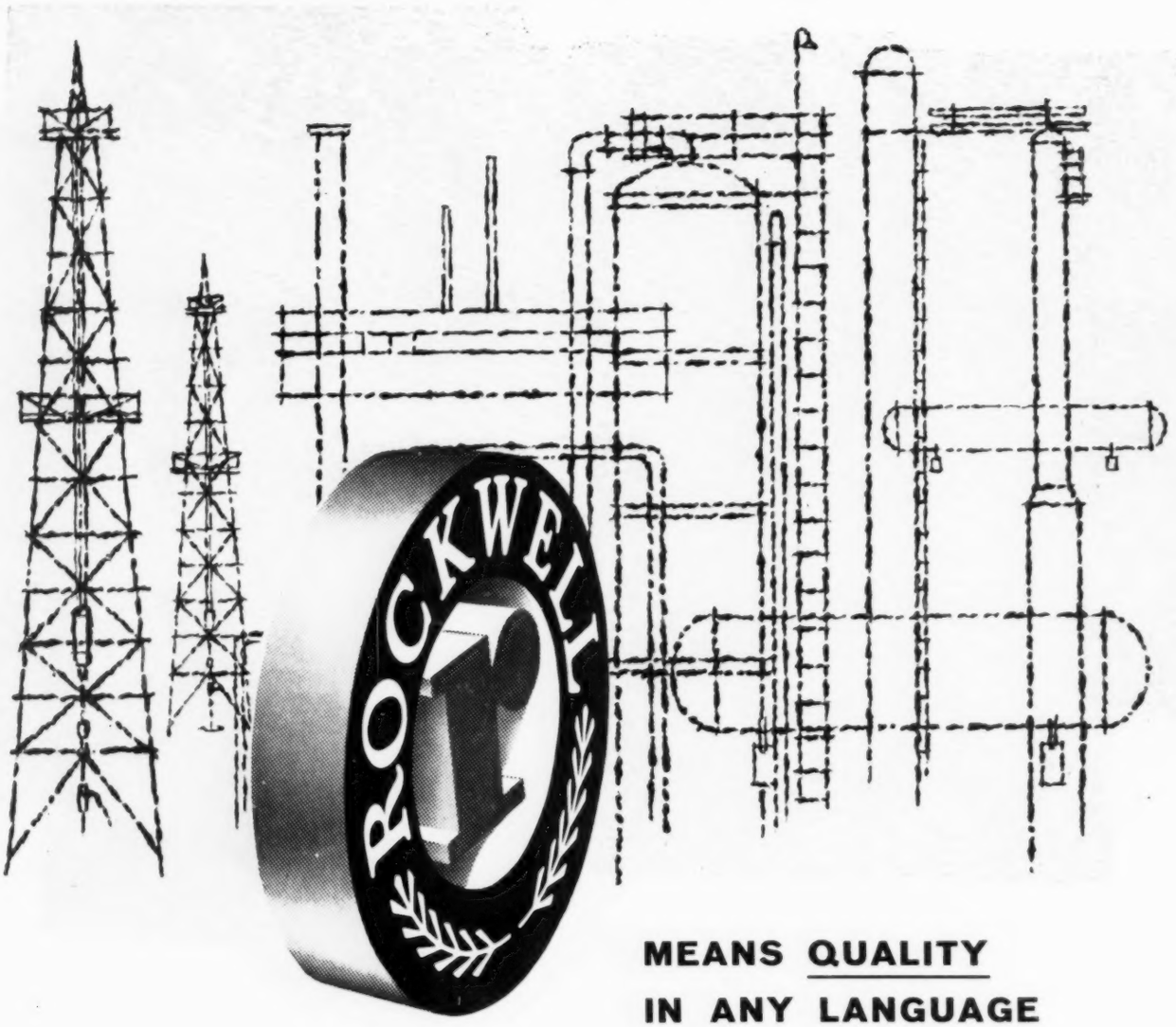


SSC "Siran" Simulated Reflection Analog built to aid in finding stratigraphic traps.



Gimbaled Cable Geophone.

Texas Instruments "Explorer" transistorized seismic amplifier system.



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STANDARD CASING GLASS JET — 3½" and 3½" OD — 1, 2, 3, 4 or 6 holes per foot.

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SUPER FORMATION GLASS JET — 4½" OD — 1, 2 or 3 holes per foot.

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semiconductor-components division of Texas Instruments.

Longer battery life is assured, since the "Explorer" draws only nine amperes from the 12-volt battery. As relays and pilot lights do not normally operate after the first breaks, only six amperes are required for most of the operating cycle. Power-drain and setup time are also reduced by the completely transistorized system, since no warmup is required before operation.

The "Explorer" has a frequency-response range from five to 200 cps, with a broad dynamic range of 100 db. Linear, time varied gain, or AGG amplification, is selected through a control switch. Then, adding to this flexibility, six choices of automatic gain control speeds are provided. These range from 200 db per sec to 20 db per sec with compression speed-expansion speed ratios available at 3/1 and 1/1.

The "Explorer" can be used with any seismic camera or magnetic recorder. Two outputs from the system are provided. One furnishes 0.5 volt for magnetic recorders, and the other furnishes an output capable of driving a 200-cps galvanometer 1 in. peak-to-peak. The output level can increase to seven times the normal level given before signal clipping occurs. Also, since no output transformer is used, a better frequency response is achieved.

A constant *K* high-cut filter is provided with six cutoff frequency positions ranging from 40 to 160 cps. The low-cut filters are of the single section constant *K* type, also with six cutoff frequencies which range from 14 to 40 cps. The filters may be bypassed either before first breaks or for the entire record.

In order to simplify field operation, all controls have been color-coded to match the function group to which they pertain. Also, gain controls have been calibrated in decibels so that the operator will know the exact amount he is increasing or decreasing his gain.

Sinclair Dip Plotter

Seismograph Service Corp. began commercial production during the past year of the Sinclair Dip Plotter which was designed by researchers in the Sinclair Research Laboratories. This machine utilizes the seismic information directly from a seismogram, and computes and plots the position of the reflection on a cross-section without hand calculation or tabulation. The machine is fully automatic, plotting depth points at approximately 10 times hand speed. Operating with a "linear increase of velocity with depth" velocity assumption, the machine plots the point in the subsurface from which the shock wave was reflected in two dimensions.

The Sinclair Dip Plotter is an electromechanical device consisting of a sensing unit coupled with a plotting unit which rapidly and accurately plots migrated dip segments directly from conventional seismograms. In operation, a seismogram is positioned beneath the sensing-unit indices, and a cross-section sheet is positioned beneath the plotting arm; accuracy is said to be equal or superior to conventional techniques, and speed is greater from 800% to 1,000%.

Sinclair Dip Plotter: Operator scanning a seismogram.

Sinclair Dip Plotter: Arm and traveling block over standard cross-section paper on which migrated depth points are marked.

Field Office Playback.

Sinclair Dip Plotter

Because of its speed, the device makes it practical for a geophysicist to "try" many events seen on the records to determine their validity. Many data are plotted which would not be used if computed by hand. A better interpretation of the seismic information is, therefore, usually possible. Since the machine will easily handle cross-sections of most any scale, the original cross-sections may be used directly by the machine without the need for complete replotting.

The plotter consists of a sensing unit which measures distance from a reference point to a reflection event on the seismogram, and measures the angle at which the event crosses the seismogram. These mechanical measurements are converted into electrical quantities, and are fed into servo-mechanisms which compute dip and depth. The sensing unit is moved to the correct position on the seismogram by the operator.

Operated in conjunction with the senser is a plotting unit which positions a plotting guide on the cross-section according to the dip and depth signals received from the servo-mechanisms. The dip segment is then marked directly on the cross-section.

A variety of cross-section scales may be used with the plotter. The vertical and horizontal scales, however, must be identical.

The dip plotter was first developed by Sinclair to facilitate the handling of a large number of offshore seismograms; but, when that work had been completed, the device was found to have great utility in the review and recomputation of problem areas.

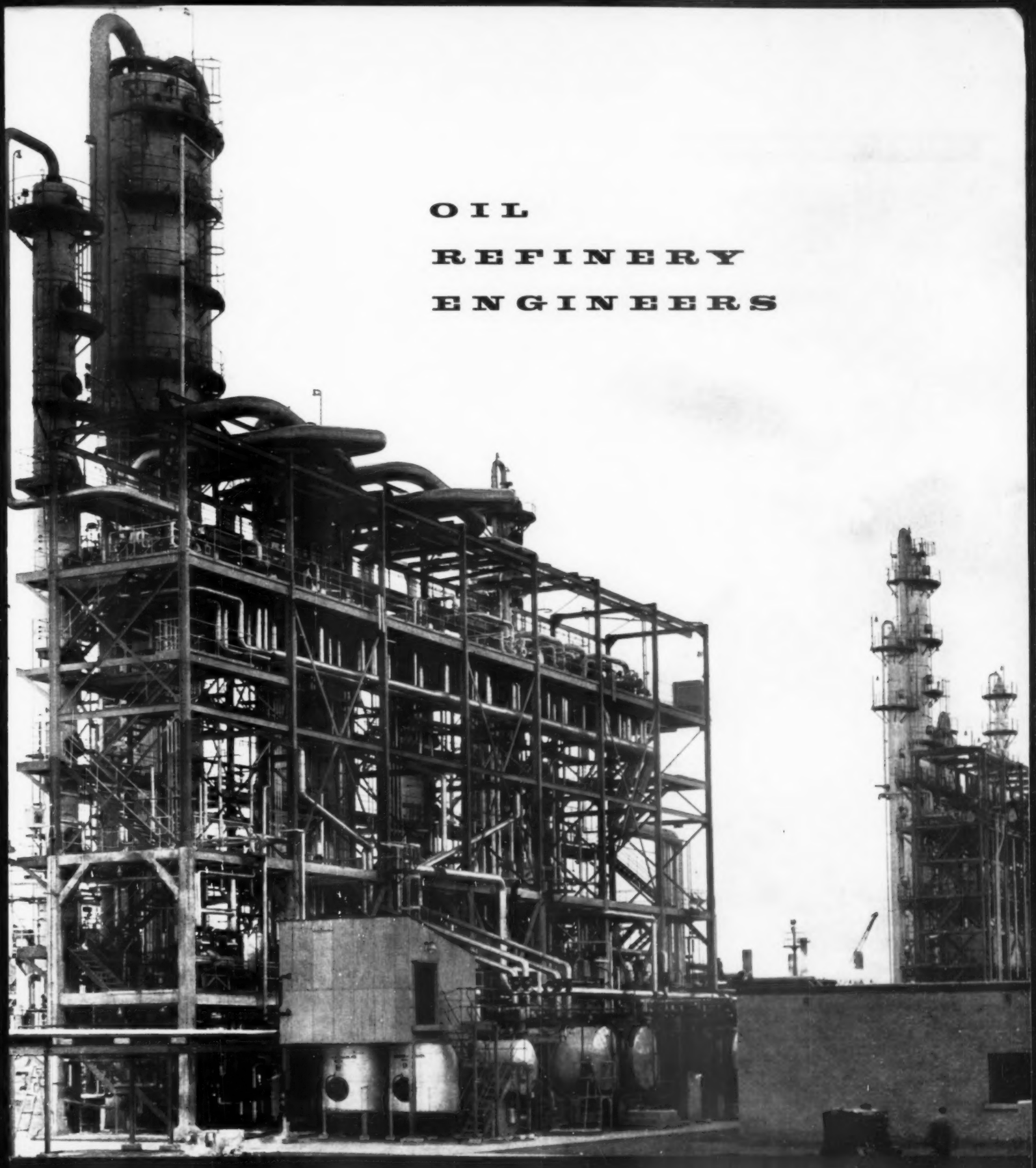
Field Stereoscope

A single-prism stereoscope weighing less than 2 lb has been developed by Brookline Inc., Salt Lake City, for field use. It may be carried flat-folded in a carrying case, and opened in one motion to give entire overlap area of two photos. Frame is sturdy aluminum.

Field Office Playback

Electrodynamic Instrument Corp., Houston, has developed its PB-50 series for the field playback office. The PB-50 eliminates the use of a recording truck as a playback unit, and provides on-the-spot processing of seismic data. Single-console construction of the PB-50 facilitates relocation from one prospecting area to another.

From magnetic tapes recorded in the field, the PB-50 photographically produces time-corrected cross-sections 24 in. x 72 in. Cross-section presentation can be in normal ("wiggly") trace or variable-density form. The system utilizes sequential playback techniques. The PB-50 provides dynamic (normal moveout) corrections of 250 ms at a maximum rate of 500 ms per sec, and static (weathering and elevation) correc-



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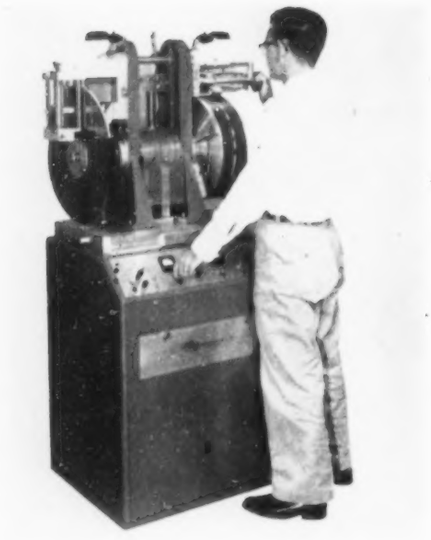
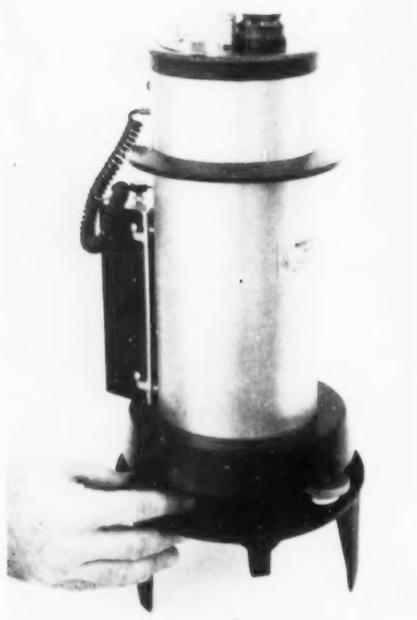


Omnitape Accessories.

Seismod Recorder.



New TI-Worden Master gravity meter shown with leveling screw being operated.

tions of ±100 ms. Any type of spread arrangement can be handled. Cross-sections can be referenced to any desired datum. The playback method incorporated in a PB-50 is determined by the user's field recording equipment: direct, FM, or PWM.

Omnitape Accessories

Hale Instruments Inc. has added three new accessory attachments for the Omnitape magnetic-media transcribing system. Transport and track spacing mechanisms have been provided for magne-discs so that Omnitape now includes all seismic tapes and discs in popular usage. A new head bank assembly now permits automatic and continuous transcription from one seismic tape having odd spread configurations to a standard spread arrangement on the receiving tape. This attachment also permits single-revolution transcriptions, increasing the production capacity in the order of 10 to 1.

Another important accessory unit now available is a pen-writing attachment which produces a paper record simultaneously with the magnetic transcription. This enables the operator to have a visual record of the actual data being transcribed.

Seismod

The Seismod is an auxiliary instrument designed to produce a variable-density seismogram and simultaneously preserve the envelope character of each reflection. Developed and patented by Sinclair Research Laboratories, the Seismod can be used with any conventional seismic amplifiers and recording oscillographs. It is being manufactured by Electro-Technical Labs, Houston.

Seismod presentation consists of a 1,200-cps carrier amplitude modulated with the output from a conventional seismic amplifier. After amplification, this modulated carrier drives conventional galvanometers in any ordinary recording oscillograph. In order to keep the Seismod traces channelized, an adjustable clipping circuit prevents excessive trace excursion. Individual controls for modulation level and overall output level are provided.

Since Seismod utilizes a direct-amplitude modulated carrier, the envelope is identical to the corresponding "wiggly line" trace. Complete preservation of trace character is thus assured. Seismod combines the advantages of both variable-density and variable-area presentations while graphically retaining all subtle amplitude variations.

All 12 channels and master oscillator are transistorized on individual plug-in component boards for easy service. Seismod is also available in one or two trace models for use with sequential playback systems.

Enlarge Line of Gravity Meters

Texas Instruments Inc. has expanded its line of gravity meters from one to three basic classes. Formerly, the TI-Worden Meter was offered in one class only, in either Standard or Geodetic models. The three new classes are the Master, Prospector, and Educator—each available in Standard or Geodetic model.

Through use of the TI-Worden fabricated quartz meter system sealed in a partial vacuum, these gravity meters are essentially independent of temperature and altitude effects, and weigh only from 7½ lb to 10½ lb, depending upon class and model. The master has increased small-dial range and full 90-deg latitude temperature compensation. A low-power temperature-stabilizing feature has been included in this meter to obtain even greater linearity for all gravity readings, regardless of the range and severity of temperature fluctuations. The temperature stabilizer is powered by four standard "D" size flashlight batteries.

Rapid Reconnaissance

Airborne surveying equipment capable of charting an area the size of West Virginia in 12 hours has been developed by the Air Research and Development Command's Wright Air Development Center, Dayton, Ohio.

The equipment is "similar to but more sophisticated than" equipment usually used in oil exploration and geophysical research, the Air Force said. The new equipment, however, holds promise for the oil industry, officials added.

Utilizing an improved version of the US Air Force high-precision short-range navigation radar (HIRAN), the new equipment can accurately photograph areas which would take many months or even years to survey with ground teams.

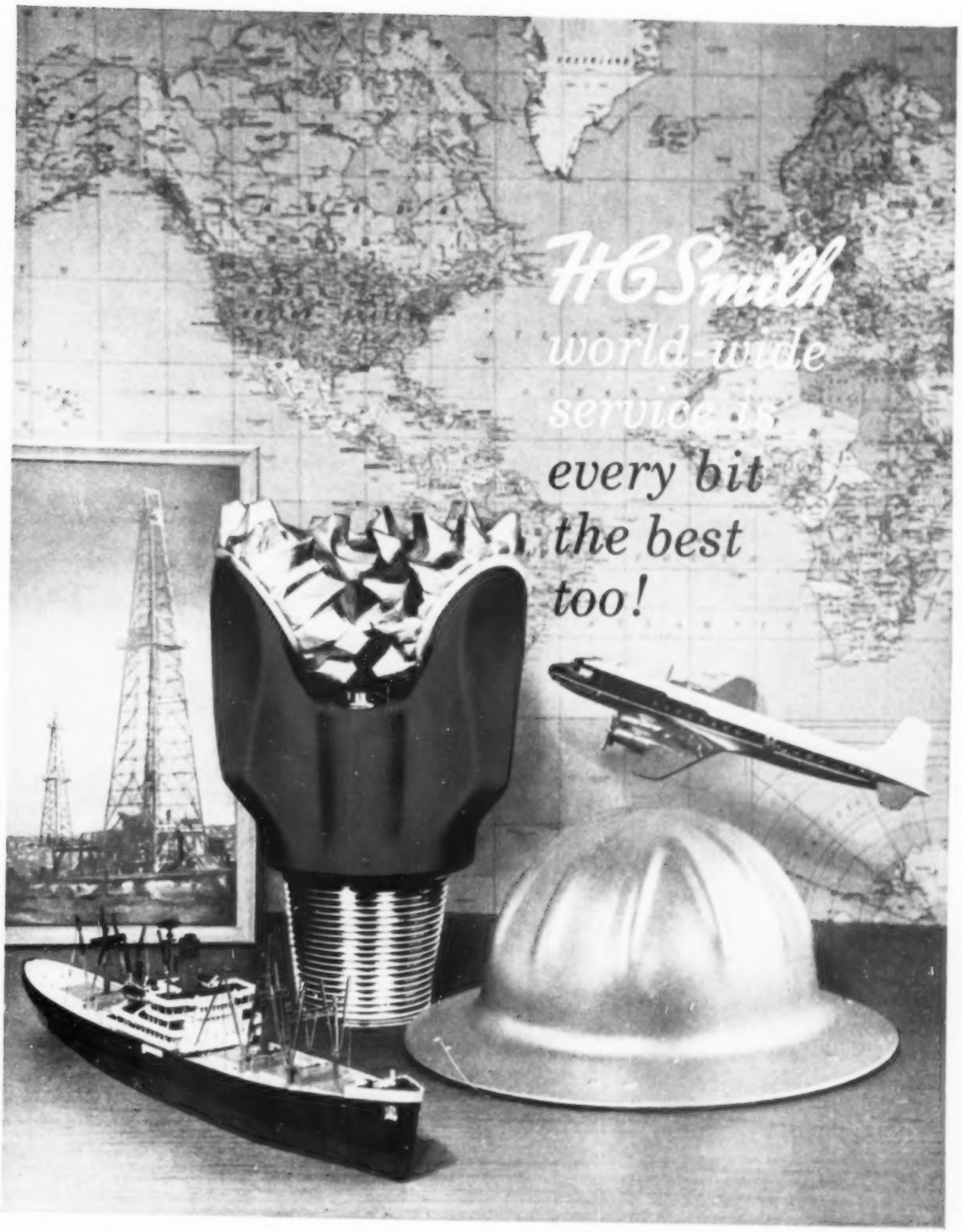
The new electronic surveying and mapping system, being tested in C-130 aircraft, was designed primarily to insure accurate aerial maps and charts for use with modern and future weapons. The system will also span oceans to provide true distances and relative locations between the major land masses of the world.

Portable Radiolocation System

Hastings-Raydist Inc., Hampton, Va., has built a transistorized radiolocation system which has been miniaturized to the point where it can be transported into remote areas by light aircraft or helicopter, station wagon, jeep, or small boat. Two required base stations can be set up in a half hour and operated from a 24-volt battery. Ranges are from five miles in heavily wooded areas to 45 to 65 miles. With 100-watt and 100-ft antennas, a somewhat heavier system is operable at distances of 150 miles.

Three New SIE Systems

Southwestern Industrial Electronics Co., a Division of Dresser Industries Inc., announced during the past year a new series of geophones, three complete seismic systems, and a seismic adapter unit. The geophones are the S-23 series. The three systems are designed to help get records and make interpretations in areas where recording has been difficult or impossible previously. They are the MS-15A, a light-weight single-package FM magnetic recorder and monitoring system for field use; and the MS-12 and MS-18 GeoData systems—office playback units for display and interpretation of field records. MS-17 series adapter



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NEW TOOLS FOR THE GEOPHYSICIST

The SIE MS-18 GeoData System.

The SIE S-23 Geophone.

Seismic Surveying by Helicopter in Alaska.

Seismic Surveying by Helicopter: Looking inside S-55 recording instruments.

units allow other types of magnetic tape to be processed in the GeoData systems, and provide still more flexible data presentation.

The S-23-series high-sensitivity geophone has been designed for high performance, and quick, easy field service in any land or marsh application. Standard models have natural frequencies of 14, 18, and 28 cps; and models with natural frequencies ranging from 7 to 75 cp are available to special order.

S-23 geophones are contained in a hermetically sealed steel case containing an inert gas to prevent condensation. A steel cap with extended flanges supports the leads where they emerge, minimizing fatigue breakages due to repeated short-radius bending. A new magnetic structure achieves high output sensitivity with no weight increase over previous models. Improved spring design gives lateral stability, reducing spurious response from horizontal energy. Flexible plug-in leads facilitate field testing and replacement without the need for soldering.

The MS-15A Field Recording System is a "one-package" unit for field magnetic recording and dry pen-written monitoring. The entire system is housed in a single unit; and, since no space-consuming darkroom facilities are required, the MS-15A may be installed in portable recording cabs, the smallest pickup truck, marsh vehicle or offshore recording boat. The MS-15A was designed expressly for field recording to provide records for the MS-12 GeoData system which was previously described in WORLD PETROLEUM (March 1958, p. 66-68). It uses high-fidelity frequency-modulation method to obtain reproduction of the field seismic signals. Except for geophones, the MS-15A is a complete field recording and monitoring system.

The MS-15A produces high-fidelity FM recordings from 24 broad-band linear phase-shift seismic amplifier-FM modulator combination channels specifically designed to take full advantage of the dynamic range capabilities of standard SIE magnetic tapes. Every trace can be observed before recording, for noise level and relative trace amplitude, on the special visual-presentation screen. An innovation is the modulation indicating meter which allows preset modulation levels to be visually checked while recording. Either pen-and-ink or electro-stylus presentation methods provide a complete, pen-written record $2\frac{1}{2}$ minutes after the shot has been fired. The sequential monitoring principle allows taking any desired number of channels from each of a group of tapes to observe the day's records on a condensed cross-section.

All units are of plug-in construction for easy field maintenance, and optional plug-in 60-cps filtering units are also available for areas where AC pickup is severe.

The MS-18 GeoData System incorporates all the features of the MS-12 GeoData system, and has been specifically designed so that the full value of compositing magnetic recordings can now be realized on a production basis.

Although the system can process either FM or AM field tapes, all compositing processes utilize FM recording. Time corrections are inserted at the same time the composite is made, so that no time is lost in making a corrected record.

The versatility of the MS-18 allows use of all the popular compositing techniques for improving the quality of seismic records, and the system is particularly adaptable where the multiple-ray-path-to-a-common-reflection-point technique is used. Increased delay-line corrections to 400 ms, plus necessary proportioning corrections, make the MS-18 particularly useful for shallow or low-angle beds where large ΔT corrections are necessary.

Compositing is continuously pen-monitored to provide a permanent record of compositing effectiveness. This feature allows compositing results to be instantly checked so that any degeneration will be immediately recognized. Use of transfer tapes keeps compositing current, so that in any compositing sequence an undesirable field tape can be deleted from the sequence without losing or causing deterioration of previously composited data. Up to 10 field tapes can be composited directly without recompositing. For composites of more than 10 field tapes, transfer tapes may be recomposited.

The MS-17 GeoData Adapter Unit used in conjunction with any Sie MS-12 or MS-18 GeoData system, provides variable density, variable area, multiple clip-trace, and conventional optical cross-section displays. In addition, the MS-17 can be used for techno-type tape playback.

Variable-density recording may be made simultaneously with, or instead of, standard pen-written cross-section. MS-17 units equipped with up to 50 magnetic heads allow playback of techno-type tape for subsequent analysis in the MS-12 GeoData system. Variable density of techno-type tape playback functions are combined in a single unit when both features are desired. No removal of the drum is necessary in the combination unit to convert from one function to the other.

Any form of timing line presentation on the variable-density cross-section is available by any means of an auxiliary unit which preprints timing lines prior to developing the record.

Seismic Surveying by Helicopter

During the summer of 1958 Petroleum Helicopters Inc., Lafayette, La., pioneered the use of Sikorsky S-55 helicopters to conduct a seismic survey which was completely airborne. The seismic instruments were themselves mounted inside the fuselage of a S-55 helicopter, which was also equipped as a photographic dark room. This is a significant improvement over the previous methods of carrying seismic instruments by helicopter. The principal advantages of this new system are as follows:

a.) Ability to carry up to 1,000 lb with the Sikorsky S-58 helicopter, enabling complete instrumentation to be carried plus

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photographic dark-room equipment.

b.) The equipment may be based, with the helicopter, at a permanent operational base for maintenance and repairs, and flown out to the operational area each day. Similarly, fast repairs and maintenance can be performed with minimum delay by flying to and from the job.

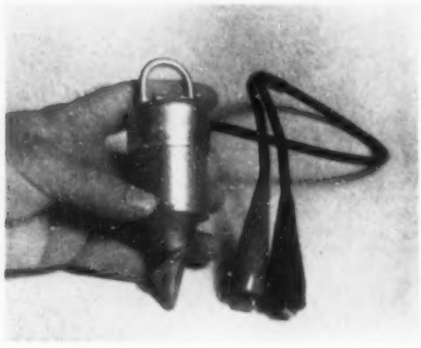
c.) Ability of the helicopter to transport the seismic instruments into almost any inaccessible location, without benefit of roads, streams, or other means of navigation.

d.) Speed with which the instruments can be moved from shot hole to shot hole, especially in jungle, mountainous, or muskeg terrain.

e.) The ability to use the helicopter as a flying ambulance in case of emergencies.

Auto-Seis Geophones

Recording Oscillograph



HS-1 4.5 cps Geophone

Auto-Seis Geophones

Hall-Sears Inc. has developed a self-orienting in-cable geophone for automatic planting. The Auto-Seis unit will operate in any position within 30 deg of horizontal. It can be arranged on multiple jumper cables for star patterns or on the main spread cable for in-line planting. In either case, connections to the basic unit can be obtained with either a plug-in leader or by solder connection.

Recording Oscillograph

The trend toward record sections has added to the requirements for a modern oscillograph. To meet these, Hall-Sears Inc. has developed the Model HS-600 recording oscillograph contained in a cast-aluminum case which requires an input of only 12 volts DC.

The paper drive is powered by a 400-cycle three-phase hysteresis synchronous motor. The frequency of the power supply used to drive the motor is fork-controlled and selfcontained in the oscillograph. Both the fork drive and the three-phase inverter are transistorized and require only a 12-volt DC input. Paper speeds from 3.5 in. per sec to 46 in. per sec are selectable in steps by simple gear changes.

The timing lines are made by a flasher timing system. The heart of the system is a special glow tube which extends the width of the paper. A fine uniform line is obtained all the way across the record. The high voltage required to fire the tube is generated by selfcontained transistor circuitry, and requires only a 12 volt DC input.

The timing lines are driven by either the fork or an external signal such as a timing reference recorded on magnetic tape. In either case, the start of the timing lines can be initiated by the time break, and thus effect alignment of the time break and first major line. An automatic shutter is provided to blank out all exposure of the paper prior to the time-break signal. A blaster with a remote firing interlock is required.

A new technique is used in handling the paper. The storage magazines are apart and separate from the ocillograph. When all the paper from one magazine is used, it is conveniently replaced by a full magazine. The individual magazines are easily reloaded by removing the snap-on end. The receiving magazine is integral with the oscillograph, and is mounted flush with the front panel. It can be easily removed when necessary for daylight developing.

Cycle Refraction Detector

Renewed interest in the refraction technique has accentuated the need for a low-frequency miniature detector suitable for use in multiple pattern arrays. Hall-Sears Inc. has developed in the 4.5-cps HS-1, a unit for such applications.

To obtain a natural frequency as low as 4.5 cps, a dual-spring system was used which supports a dual coil which is wound for both electromagnetic and electrostatic balance. The mass of the suspended system is sufficiently heavy to reduce the electromagnetic damping to an optimum level. Rugged construction makes it unnecessary to lock the coil or short the leads when transporting the geophone.

Amplifier System

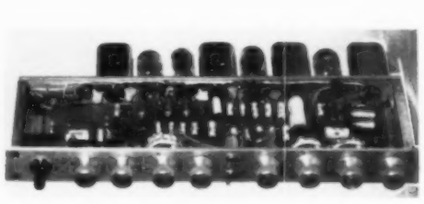
One development at Hall-Sears Inc. during 1958 was the Model HS-100 Amplifier System which combines 12 amplifier channels, transistorized power supply, and control and test functions in one 57-lb rugged unit. The selfcontained transistorized power supply ends the maze of power cables which complicate portable operation. The problem of matching power supply and load is eliminated. There is no necessity for an oversize power unit to meet possible future additions, since each 12-channel unit contains its own source. In addition, the high efficiency of the transistorized unit reduces the overall power requirement.

Hundreds of filtering combinations are provided by two low-cut and two high-cut filters in each channel which are designed to eliminate harmonic distortion problems. Either one or two filter sections can be selected independently to provide different slopes, while six frequency positions insure optimum response on any prospect. Provision is made for relays to remove filtering automatically before suppression "trips," or to remove filtering during magnetic recording by operating only one switch. The filter relays, which are optional, are of the plug-in type and can be installed easily at any time.

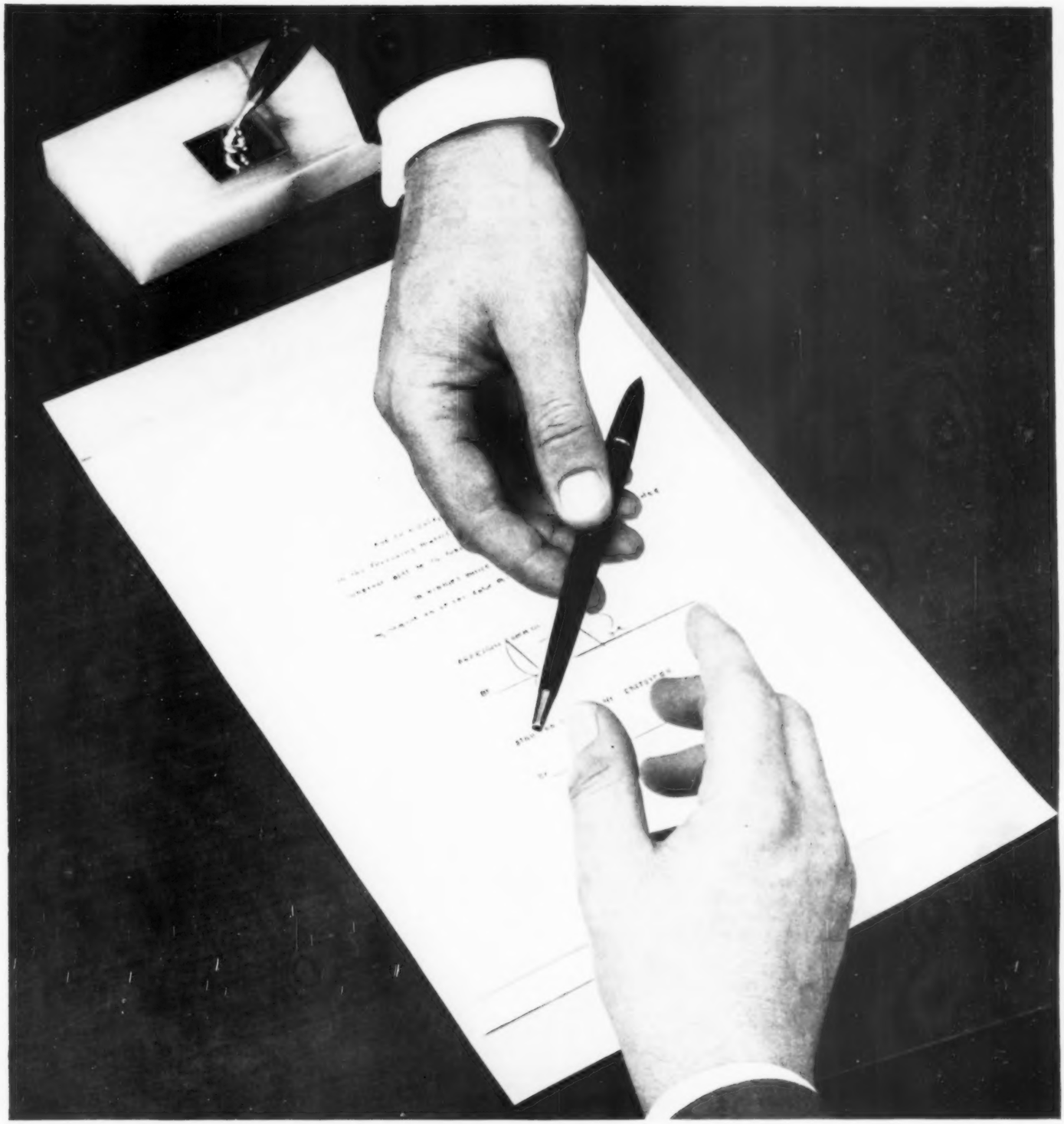
Four outputs are available from the HS-100. In addition to the conventional standard and mixed-output plugs for galvanometer drive, a magnetic recording output is provided with sufficient output level to modulate tape recorders of either the carrier or bias type.

Dual gain control provides logarithmic control over the entire dynamic range of the amplifier. The first control point is at the secondary of the input transformer, and the other follows the first amplifier stage suiting the unit for magnetic record playback applications.

A four-position AGC switch assures precise adjustment of AGC attack and decay times to match the gain control action to the energy pattern of the area being surveyed. Vacuum-tube diodes with their shifting characteristics which require tedious and expensive matching have been eliminated. Instead, the first three amplifier stages are protected by silicon "lossers." A substantial reduction in power requirements



HS-100 Individual Amplifier Channel



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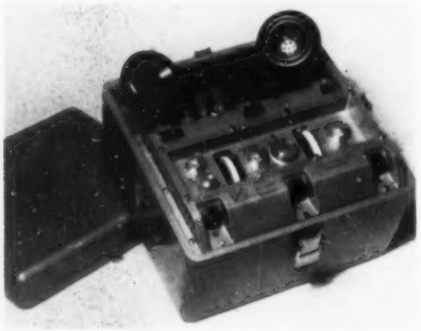
is thereby achieved by the elimination of thermionic AGC diodes.

The control unit provides conventional suppression operation plus other adaptation, through the auto-expander, the gain of all the individual channels can be controlled and varied simultaneously in accordance with the energy pattern of traces 1, 6, and 12.

The remote-control unit allows all essential system functions to be controlled with the unit covers in place. This feature (optional) simplifies mounting the units for use with magnetic recording equipment, and speeds operation. When operating portable, it is possible to use the HS-100 with the waterproof cover intact and without exposing the instruments.



Hall-Sears Blaster

Blaster Handles 1-50 Charges

The Hall-Sears Inc. Model HS-1200 Blaster provides for the firing of from one to 50 charges simultaneously and pulse shaping of the time-break signal for tape recording.

Firing voltage is generated from low-voltage batteries by a new transistorized power supply. A front panel switch selects either 300-, 600-, or 1,200-volt ranges, with the firing voltage continuously variable from zero to the maximum of the particular range selected. As a result, the unit is suitable for either single- or multiple-charge operation.

To generate a time-break pulse suitable for all tape recording applications, pulse-shaping circuitry is incorporated. The time-break signal is transformer-coupled to a "one-shot" multivibrator. Both the amplitude and width of the output pulse from this circuit is selectable by controls mounted on the front panel.

In addition to two meters, one for checking the cap and the other for indicating the charge on the 20 mfd paper capacitor, a visual firing monitor is also mounted on the front panel. This monitor reveals the flash of the cold cathode tube, and indicates to the shooter whether or not the blaster has functioned. In the event of a misfire, the shooter can quickly ascertain whether the malfunction is in the blaster, the caps, or the remote-control circuitry.

Seismic-Data Reduction System

Sonoprobe Improvements

Since the Marine Sonoprobe first was announced in the March 1957 exploration issue of WORLD PETROLEUM, improvements have been made in recording techniques. As originally designed, the record emerged as a strip paper chart as the boat progressed. It was found that this left something to be desired for laboratory study. Fairchild Aerial Surveys Inc., accordingly, developed a system of recording all the information received on the Marine Sonoprobe on magnetic tape. This recording is made in addition to the strip chart which is produced as the boat progresses so that the value of the strip chart for an immediate look at what is happening is not lost. At the same time, however, the magnetic tape retains all the infinite detail of the many echoes which are returned from the bottom and below.

Subsequently, in the laboratory, the magnetic tape is played back by an oscilloscope, and the oscilloscope is phtotgraphed with a continuous-strip 70-mm camera. Contact prints or enlargements from the 70-mm strip of photography can then be studied in great detail in the laboratory, and they will display everything which was recorded on the magnetic tape. An additional advantage of the technique is that the ratio of the horizontal scale to the vertical scale of the record can be altered at will in the playback, thus providing a more nearly 1:1 ratio between the two, to make it easier for the interpreter to study the formations.

Seismic-Data Reduction System

Electrodynamic Instrument Corp., Houston, has introduced its C-850 data-reduction system designed to produce time-corrected magnetic tapes and photographic cross-sections from field-recorded magnetic tapes. These cross-sections can be photographically plotted in conventional-trace, variable-area, or variable-density presentation. Two independent camera units permit simultaneous cross-section plotting on 42-in. x 72-in. and 24-in. x 72-in. records in any two of the three available photographic methods. If desired, one combined cross-section 72-in. x 72-in. can be plotted.

Programmed patch-plugs can be designed to enable mixing, compositing, record stacking, isopaching, etc. The utilization of programmed patch-plugs reduces the usual time-consuming task of setting up for various modes of operation.

Static corrections of up to 200 ms are applied instantly by inserting a prepunched card into the magnetic-head assembly of the playback or reproduce-tape drum unit. Dynamic corrections are applied through the use of a 400-cps servo-controlled magnetic delay line. The maximum dynamic correction available is 400 ms at a maximum rate of 500 ms per sec.

Portable Geopac

A portable Geopac unit, which allows the production of fully corrected seismic records in the field and which provides extreme flexibility with respect to types of ground spreads, has been developed by the General Geophysical Co., Houston. Space occupied is slightly more than a cubic foot, and weight is approximately 50 lb. The accompanying power and switching unit weighs only 45 lb.

Velocity information can be set in the General Portable Geopac so that it is not necessary to have cams cut. With the Portable Geopac, 16 ordinate points can be set to give the proper moveout for any area. Any arrangement of pickup points with respect to the shot hole is permissible.

The Portable Geopac uses a standard type tape, 24½ in. long and 6 in. wide. The Portable Geopac makes fully corrected seismic records right in the field, so tapes do not have to be sent back to central offices. Only the simplest of printing equipment is needed to obtain complete record sections.

Infrasonic Amplifier

Amplification of fractional-microvolt signals may now be accomplished with a new galvanometer-phototube amplifier, built by Geotechnical Corp, Dallas.

The amplifier provides a voltage gain of ¼ million, a noise level of less than 0.025 microvolts, and an 8-hour drift of less than 0.1 microvolt rms referred to input with a 5-cps galvanometer installed. It employs an optical beam-splitter, twin mutual-load photocells, a cathode follower output, and a Geotech galvanometer.

Multi-Curve Vs. Acoustic Log

A velocity logging system giving five simultaneous logging records on one run of the tool has been developed by Empire Geophysical Inc., Fort Worth. The log has these simultaneous features: single-receiver acoustic log; dual-receiver acoustic log with choice of 1-, 2-, and 3-ft spacing of receivers and switching in the hole; choice of accompanying SP or gamma-ray log; dual-receiver linear velocity curve; and integrated travel time.

HANDBOOK OF THE PETROLEUM INDUSTRY, edited by G. Shell and H. A. Dossett, published by George Newnes Ltd., London; 25 shillings: Although not designed as a textbook on petroleum, it does present a wealth of information on many phases of the industry which may be of interest to young people considering a career in the petroleum industry. It will be useful to active oil men as reference material on facets of the industry with which they are not intimately concerned. Fifteen chapters discuss various oil activities within a space of 200 pages.

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Shale-Oil Activities

(Continued from page 77)

oil-shale formations in that area of northwestern Colorado have a higher potential oil content and a greater bed thickness than previously believed.

Research workers at the bureau's Laramie, Wyo., station said that their studies indicate continuous oil-shale beds from 780 ft to 1,980 ft thick, assaying an average of 25 gal of oil per ton. A square-mile segment 1,980 ft thick would contain the equivalent of 2¼ billion barrels of oil. Although drill cuttings are not as reliable as drill cores for making assays and estimates, bureau representatives said that cuttings can be considered "a reasonable gauge" of shale richness.

The bureau is compiling, for publication in 1959, assay results for all drill cuttings and cores obtained during the past several years. The report will cover 62 oil-shale sections, of which only 11 have been previously published. A lithology also is in preparation. The bureau and the Geological Survey are collaborating in revising reserve estimates as new data are developed.

A mineral analysis is being made on 25-gal-per-ton sections of each core assayed at Laramie, and the oil recovered by Fischer Assay also is being subjected to routine tests. This information should be valuable in determining variations, if any, in the character of oil shales from the Green River formation in Colorado, Utah, and Wyoming.

Utah adopted a form of lease agreement for state-owned oil-shale lands which provides for annual rentals of from 50 cents an acre initially to $1.50 an acre after five years if the properties are not being produced. Royalties are to be 5% for the first seven years of production and 12½% thereafter, with renegotiation at the end of each 20 years. The agreement requires that the lessee conduct research and development on oil shale and report to the state annually as a condition of retaining the lease. Utah oil-shale lands are less exploitable than those in Colorado, but a position in shale can be acquired by this means at little immediate cost. Better quality lands in Colorado may be purchased outright at from $100 to $500 an acre.

Foreign developments: (Brazil) Although no active work is being done in the United States on the gas-combustion retort, a Brazilian oil-shale project has added materially to the technical knowledge available on this general method of retorting. Pilot-plant and development work on a similar process has been conducted there for the past two years. Following completion of successful pilot-plant operations, designs were made of commercial retorts employing both round and rectangular retorting vessels. Allowable sizes were studied, and structural and mechanical details fully engineered. That information now is being used in designing a prototype retort for Paraiba Valley shale.

With some modification, the same designs could be used for Colorado shale. Daily capacities for single retort vessels should be in excess of 2,500 tons, and circular retorts of 5,000- to 6,000-ton capacity are considered a distinct possibility.

Russia: The Kremlin's iron curtain has lifted slightly of late, for technical literature from the USSR has contained an increasing amount of information on oil-shale technology. Although no details are yet available on the new 10,000 b/d plant under construction at Kochtla Jarwe, Estonia, other articles have covered basic aspects of shale pyrolysis and shale-oil refining. They should be of value to USA oil-shale investigators.

Sweden: The 20% increase in capacity under way at the Swedish Oil Shale Co. plant near Kvarntorp probably results from the replacement of old retorting systems with the Kvarntorp retort. That company's experimentation continues on *in situ* retorting by the use of electrical heaters, a modification of the Ljungstrom process. Some 2,500 holes were drilled on 7-ft centers to the bottom of the shale bed, a depth of 100 ft. Heaters were placed in 85% of the holes, and oil vapors were removed from the other holes six to eight weeks after electrical power had been applied. Recovery was estimated at 70% after 16 additional weeks, and the oil and gas recovered had a heating value three times that of the electricity used. Union Oil Co. of California and the Husky Oil Co. have licensed this process for use in the United States and Canada.

Thailand: A 6,000 b/d plant in Thailand, planned as a joint venture by Thai and Japanese companies, will use a shale assay-

for all oilfield duties

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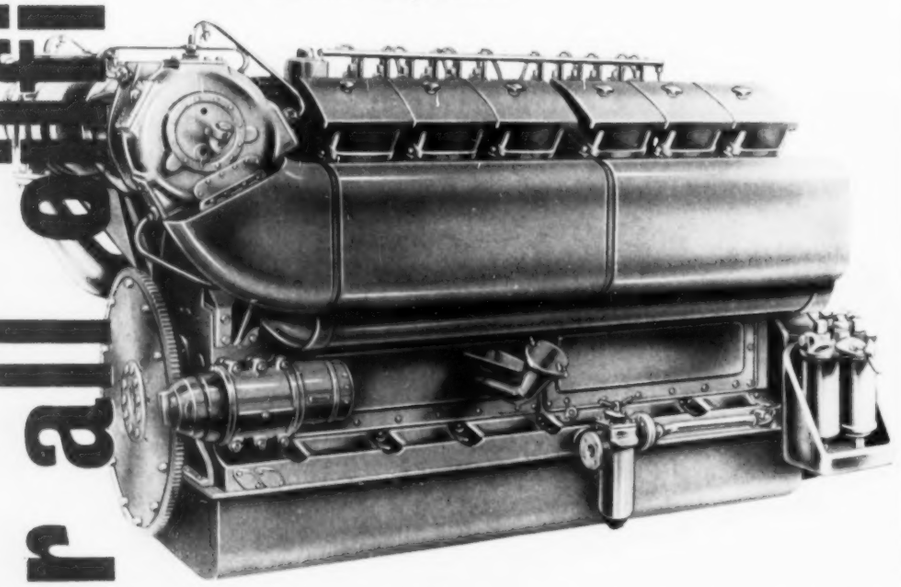

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ing 26% oil. The Japanese will provide $16 million in equipment, and an $8 million loan is sought from the United States. Detailed plans have not been made, although the processing techniques will be similar to those used by the Japanese in Manchuria.

Water for oil shale: In the United States, companies which have acquired oil-shale lands in the semi-arid reaches of northwestern Colorado now are taking steps to assure that water will be available for mining, processing, and domestic uses when they determine that the time is economically opportune for commercial operations.

Among those filing claims or seeking decrees in 1958 for water rights on the Colorado River where the Dow Chemical Co. Sinclair Oil Co., and the town of Grand Valley, Colo. The latter, a small community which confidently anticipates a great future in oil shale, is strategically situated at the edge of the major reserves on the Colorado River, the Denver and Rio Grande Railroad, and US Highways 6 to 24.

Grand Valley's dreams of metropolitan status may one day come to pass. The Colorado Chamber of Commerce, a group of hard-headed business realists, recently commissioned Cornell University's Professor F. W. Edmondson, and 30 of his graduate students, to submit designs for a city of 350,000 to be built in Colorado's oil-shale country. END

Italy

(*Continued from page 64*)

of 34 API gravity.

Monthly production of natural gas and of natural-gas liquids, which comes almost entirely from the Po valley, from January 1955 to March 1958 is reported in Fig. 2 and Fig. 3.[3]

In Abruzzi, results hoped for from the discovery of oil in 1953-54 did not materialize in substantial production. The Alanno field (discovered by Petrosud in 1953) is presently shut in, after difficulties due to increasing water content of the extracted crude. The Valle Cupa field (discovered by an ENI subsidiary) where 45 wells have been drilled in the years 1956-58, is presently producing about 100 tons per day of 24-API crude.

The best producers of oil in Italy are presently located in Sicily. At Ragusa (Gulf-Italia), 45 wells have been completed, and the average production per well is about 150 tons per day. At Gela (ENI), 10 wells are presently in production, with an overall yield of 1,000 tons per day. Five more wells are being drilled. For 1959, the production of the Gela field will be of about one million tons.

Overall crude production in Italy (including Sicily) from January 1955 to March 1958 is shown in Fig. 4.

Gela field, whose extension is not yet determined, but which continues offshore, will probably reach in the near future about three million tons per year.

Average depth of Ragusa wells is 2,000 meters. A crude of 19 API gravity is produced. At Gela, average depth is 3,500 meters; asphaltic crude of 10 API gravity is extracted by gas-oil injection underground.

Schematic geologic sections of the Ragusa and Gela oil fields are shown in Fig. 5 and Fig. 6.

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(2) Proceedings of the Meeting on Gasfields of Western Europe, Milano 30 Sept. 3-Oct. 1957. Accademia Naz. Lincei, Roma 1957.

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(4) *Bollettino Ufficiale degli Idrocarburi*, vol. 1, June 1958.

USA Crude Rise

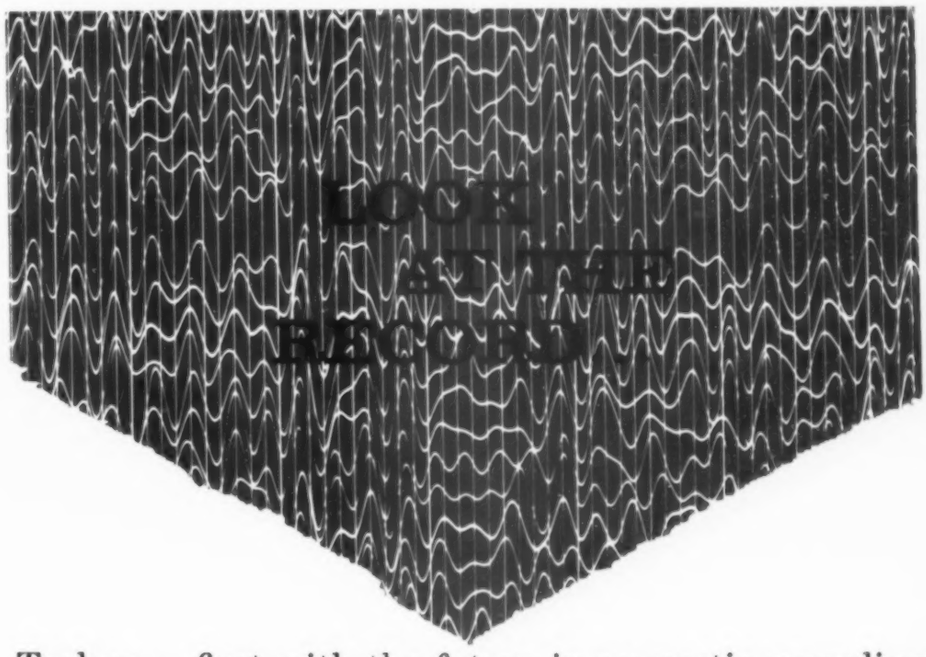
The US Bureau of Mines has forecast a 8.6% rise in crude production in 1959 in the USA. Domestic demand for all oils will be 4% over 1958.

TGT To Expand Gas Delivery

Texas Gas Transmission Corp. has filed an application with the Federal Power Commission for authorization of $40 million expansion program to gather and transport through its pipeline system up to 100 million cubic feet of natural gas daily additional and to build about 246 miles of pipeline and add 15,760 hp to the existing Texas Gas system.

Sun-Olin Chemical Plant

Construction of Sun-Olin Chemical Co.'s $11 million urea plant at north Claymont, Del., has been scheduled to start March 1959, and should go into operation by the end of the year. Sun-Olin is a joint subsidiary of Sun Oil Co. and Olin Mathieson Chemical Corp. It will use the Fauser-Montecatini process to produce urea for which license agreement was signed with the chemical firm of Montecatini, of Milan, Italy.



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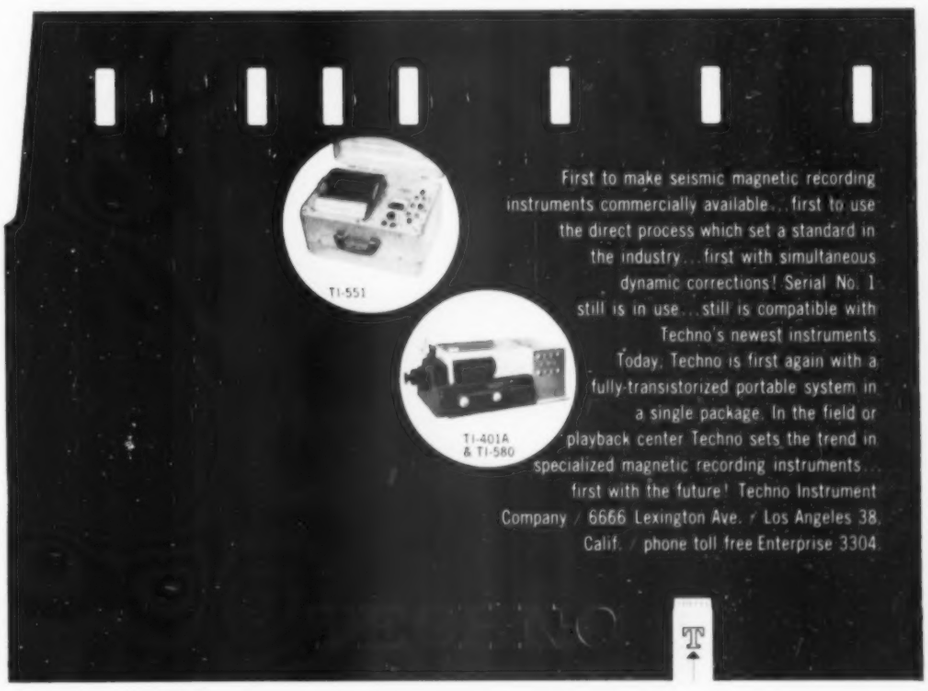
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View of Hercules' polypropylene plant at Parlin, NJ., which was taken onstream late in 1957.

Petrochemical horizons for propylene

Part V: *Propylene-derived detergents—Polypropylene*

by Peter W. Sherwood*

VIII. Propylene-derived Detergents—

Two major types of detergent draw on propylene as ultimate raw material: dodecyl benzene sulfonates (anionic detergents) and nonyl phenols-ethylene oxide (nonionic detergents). Together, these products constitute the second largest petrochemical outlet for propylene.

Volumewise, dodecyl benzene sulfonates are by far the more significant of the two. This product's big attraction is its low cost and wide range of usefulness. It constituted, at one time, 80% of all synthetic detergents production, but its share of the market has dropped to about 50% as other surfactants, notably nonionics and alcohol sulfates, have made inroads into the field.

Overall, the market for detergents, which has been so largely dominated by dodecyl benzene sulfonate, has made spectacular gains. A few production figures may serve to illustrate the growth of this commodity during the past 10 years:

Year	*Number of Detergent Producers*	*Total Detergents Output (Millions of Pounds)*
1948	17	281
1951	37	937
1954	36	1,579
1957	36	2,560

Much of the growth of synthetic detergents has come at the cost of soap consumption. Since 1954 there has actually been a slow but steady downtrend in the output of soap as synthetic detergents rose from 54% of the combined market in 1952 to nearly 75% in 1958. Only in two fields—industrial laundry and toilet use—have soaps been able to maintain a major share of the market, and the outlook is for strong growth of synthetic detergents into the toilet-soap field even at the present soap-favoring price structure.

However, the growth of surface-active agents has not come solely from displacement of soap markets plus the growth of the population. Equally important is the greater versatility of detergents. Snell[1] lists a variety of nonlaundry uses for surfactants which range from petroleum processing and secondary recovery to fluffing-up of concrete, fruit washing, textile processing, and to agricultural sprays and fertilizers.

An important characteristic of synthetic detergents is their chemical stability under conditions which cannot be handled by soap. The outstanding example here is use of these materials in the presence of calcium and magnesium ions which react with soap, rendering it useless for cleaning purposes.

There is considerable difference in the chemical stability of the synthetic detergents themselves, and this has been a factor in the replacement of dodecyl benzene sulfonate surfactants by competitive materials. Thus, the nonionics are chemically more stable; they are compatible with either anionic or cationic detergents, while the latter two cannot be used simultaneously.

In the field of alkyl aryl sulfonate production itself, there has been considerable evolution over the past decade. Here, three factors must be considered above all: the aromatic group, the alkyl chain, and the amount of inorganic salt or "builder" which is present in the product.

The preferred aromatic group has been, from the beginning, benzene. But other aromatic raw materials have been, and are being, employed in the production of alkyl aryl sulfonate detergents. Thus, in 1944 fully 25% of the output of this group of surfactants was based on the naphthalene nucleus. Again in 1950, when benzene was in very short supply, toluene-based detergents made certain inroads into the market. In the course of subsequent processing, the derived detergent products were of inferior color, and were characterized by unpleasant odor and a sticky feeling. These shortcomings can be avoided if benzene is the nucleus, and this material serves today almost entirely in the production of alkyl aryl sulfonate-type detergents.

The dodecyl chain has been derived commercially from three main sources: a narrow kerosine fraction in the C_{12} range and

* Chemical Engineer, White Plains, N.Y.

of predominantly straight-chain character, the trimer of isobutylene, and the tetramer of propylene.

The use of kerly chains has the disadvantage that a chlorination step must be introduced before the essentially paraffinic material can be employed to alkylate the benzene nucleus. Furthermore, these natural materials are of widely varying character and cannot generally meet the high specifications which exist today for dodecyl benzene sulfonates.

The use of triisobutylene has never attained wide popularity in detergents manufacture. The resulting alkylate is not very stable during sulfonation, with the result that the end product is of fairly high color. Furthermore, for purposes of detergency, an essentially straight paraffinic chain gives best results.

Thus, the preference of the industry has shifted steadily toward the use of propylene tetramer in the production of dodecyl benzene. The resulting product is readily sulfonated to yield a detergent of excellent color, odor, and performance.

One more factor which determines the character of the anionic surfactant is the amount of "builder" present in the product. This term refers to the sodium sulfate which is unavoidably formed as the product of sulfonation is neutralized by caustic.

Determining the concentration of builder are two factors: the type of sulfonating agent which is employed, and the method which is selected to remove organic sulfonate from residual sulfuric acid at the end of the sulfonation step. Briefly, the presence of sodium sulfate can be minimized by using a sulfonating agent of high SO_3 concentration; indeed anhydrous sulfur trioxide is today employed on a commercial scale to manufacture light-duty detergents containing less than 2% inorganic salt.

Still more widespread, however, is the use of strong sulfuric acid and oleum as sulfonating agent, and here the product will contain more sodium sulfate (10% to 15% inorganic salt is here the practical minimum).

The presence of a "builder" in alkyl aromatic sulfonate detergent is not always objectionable, however. It is an inexpensive extender for the active detergent ingredient, and its presence in heavy-duty industrial detergents may, intentionally, reach values as high as 60% of the total product.

Overall, the manufacturing process for dodecyl benzene sulfonate detergents is carried out in three main steps: (a) production of dodecene (or propylene tetramer), which has been discussed in a previous part of this article series; (b) alkylation of benzene to form dodecyl benzene; and (c) sulfonation of dodecyl benzene to form dodecyl benzene sulfonic acid which is neutralized to the detergent-grade sodium dodecyl benzene sulfonate.

Industrially, the tetramerization of propylene and the alkylation of benzene is normally carried out by petroleum refiners who can take advantage of their raw-materials position and who are able to take advantage of the lower costs which are associated with large-scale production in operations of this type.

The sulfonation step, on the other hand, is generally (but not always) carried out by the producer and marketer of the finished detergent. This step lends itself more adequately to economic operation on a relatively small scale, and details of the process can be changed from time to time to meet the demands of the market.

In the following discussion, we shall briefly discuss some of the main technical points which are involved in the production of dodecyl benzene and its sulfonate, i.e., in the two steps of the synthesis which start from benzene and propylene tetramer.

Production of Dodecyl Benzene: Dodecene, the olefinic tetramer of propylene, can be made to react with benzene in the presence of a number of alkylating catalysts. Commercially most important today are aluminum chloride and hydrogen fluoride. The use of sulfuric acid as catalyst in dodecyl benzene production has become less significant.

Where aluminum chloride is used, a minimum catalyst concentration is observed for effective execution of the reaction, but only little is gained by exceeding this value beyond a reasonable margin of safety. $AlCl_3$ is effective only in the presence of hydrogen chloride which may be introduced either as such or, less advantageously, by addition of a small amount of moisture to the system.

When anhydrous hydrogen fluoride is chosen as catalyst, it must be employed in large amount; a tpical molar ratio of HF to feed dodecene is of the order of 4:1.

Regardless of catalyst employed, the controlling variables are operating temperature, and mole ratio of reactants. Effect of these variables has been explored by Sharrah and Feighner[2] who found that yield attains a near-assymptotic maximum value at benzene-dodecene ratios of 8 to 10.

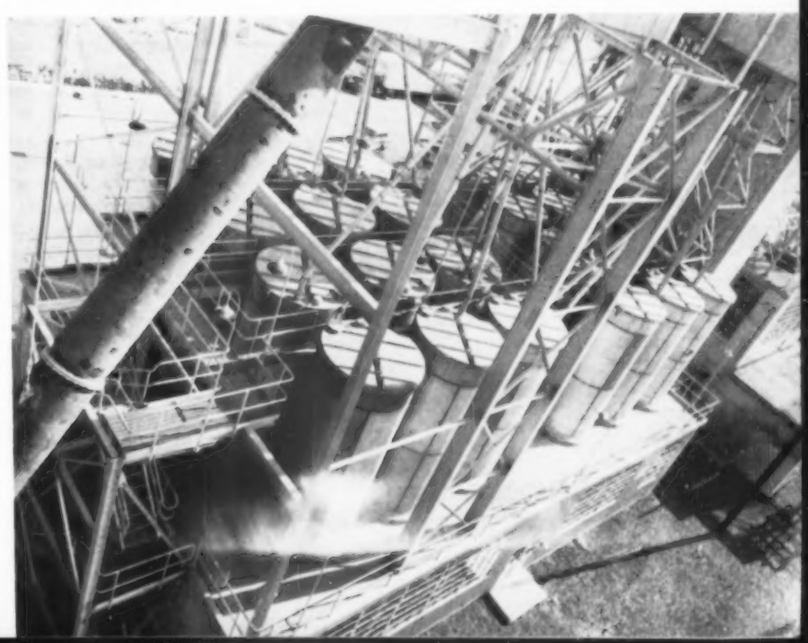
As expected, the amount of heavy by-product declines with rising benzene-dodecene ratios up to this value. In aluminum-chloride catalysis, bottom-product formation passes through a maximum at reactants' ratio between three and four, and declines rapidly below this value. This unexpected phenomenon is believed to be caused by catalyst inactivation at high dodecylene content in the mixture. Ultimate yield may be bolstered by recycling some bottom product to the reaction batch.

For a given reaction time, an optimum reaction temperature is observed. Aluminum-chloride catalysis calls for operation at not less than 30 C; decline in yield above this temperature is only very gradual. HF-catalyzed alkylation is carried out at 0 C to 10 C.

In practical operation, benzene-olefin ratios below optimum yield value may be made preferable by overall economic considerations. The alkylation reaction is carried out in glass-lined equipment, since the presence of iron in the product has a harmful effect on its usefulness in detergents synthesis.

The overall process for dodecyl benzene synthesis may be illustrated by the flow in in a commercial plant where HF catalysis is employed. Here, the rate of dodecene feed is gradually added to a mixture of benzene and anhydrous hydrogen fluoride. The rate of addition is carefully controlled to maintain the temperature of the reaction system below 10 C. After addition is complete, the reaction is permitted to continue at the same temperature level until the conversion is complete. Hydrogen fluoride is finally removed from the system by stripping at atmospheric pressure, and is recycled. The hydrocarbon system is then freed of unconverted benzene, and is thoroughly washed. Dodecyl benzene is finally recovered in purified form by vacuum distillation. Overall yield is in the range of 85% of theory.

Sulfonation of Dodecyl Benzene: Alkyl aryl sulfonates are produced from dodecyl benzene by sulfonation with SO_3, anhydrous or in the form of oleum, followed by



Storage bins at Hercules' polypropylene plant.

caustic neutralization. The active ingredient of the desired surface-active agent is thus the sodium salt of dodecyl benzene sulfonic acid. It is today marketed in a concentration ranging from 25% to 97% active ingredient. The remainder is sodium sulfate. The percentage of surface-active agent which is present in the sales product depends on the use for which it is intended.

As will be seen below, the use of oleum as sulfonating agent introduces into the product depleted sulfuric acid, which has no further power of reaction. Upon neutralization, this is converted to sodium sulfate. Therefore, the presence of this salt in the product is practically unavoidable if oleum is used as a sulfonating agent (for many purposes, the presence of sodium sulfate is, however, actually felt to be desirable). However, for the production of certain liquid surface-active agents, the presence of the inorganic salt is objectionable, and here anhydrous SO_3 is the only suitable sulfonating agent.

In the sulfonation process most commonly employed, it is necessary to employ a molar excess of sulfuric acid (in the form of oleum). The amount required depends mainly upon acid strength and sulfonation temperature. Only in this fashion can sufficient conversion of the hydrocarbon be achieved to assure low free-oil content in the finished product.

Of outstanding importance for an efficient sulfonation process is the degree of mixing provided for the two-phase sulfonation mass. As the concentration of oleum increases, this consideration becomes of even greater significance. High concentration of free sulfur trioxide in the liquid phase may result in localized charring unless special techniques are employed. In such case, there is a tendency toward discoloration of the product.

In carrying out the sulfonation, all materials of construction in contact with the reaction phase must be corrosion-resistant to prevent iron contamination and consequent discoloration of the product.

A typical process for the production of an alkyl aryl sulfonate by batch methods has been reported by Sharples Chemicals. In this operation, a ratio of 1.66 lb of oleum is employed per pound of hydrocarbon; 20% oleum is used. The product of this particular type of operation may contain either 85% or 40% active ingredient, and may be adjusted by the method of finishing.

Dodecyl benzene is first charged to a glass-lined jacketed agitated sulfonator where it is cooled to 10 C; 20% oleum is then carefully pumped into the well agitated reactor. External cooling is provided, and the temperature of the system is maintained at 25 C to 35 C by controlling the rate of addition. After the entire batch has been introduced into the sulfonator, it continues to be agitated for 1.75 hours to allow the sulfonation to reach completion. In a pilot-plant sulfonator employed by Kircher of Sharples Chemicals Inc., the total batch time—including charging, ageing, and discharging—was of the order of three hours. The actual time required in any batch equipment depends, however, on the efficiency of cooling which can be provided and on the degree of agitation.

If the product is desired to contain 80% to 85% active ingredient, crushed ice is added to the sulfonation mass. The mass is then allowed to stand for about one hour, and the organic phase is withdrawn from the spent acid which is of approximately 63% to 65% strength. The organic layer is now charged to the neutralizer which contains a 20% sodium-hydroxide solution. The addition rate is controlled so that the batch temperature will not exceed 55 C. Thorough agitation is provided throughout the neutralization operation.

The pH is finally adjusted to 8, and the slurry is drum-dried, packaged, and is then ready for marketing.

Alternately, it is possible to produce a 40% active sulfonate by charging the unseparated product of sulfonation to a neutralizer containing 20% sodium-hydroxide solution—again making sure that the temperature in the system will not exceed 55 C. Toward the end of the neutralization step, the requisite amount of anhydrous sodium sulfate is added to the batch. The pH is again adjusted to 8, and the slurry is ready for drum-drying to produce a 40% active salable product.

SO_3 as Sulfonating Agent: The demand for detergents which are essentially free of inorganic salts has led to the recent commercial adoption of processes in which anhydrous sulfur trioxide serves as sulfonating agent. A key event which led to the development of such processes has been the commercial introduction of stabilized liquid SO_3 about 10 years ago.

For the purpose of sulfonating dodecyl benzene, vaporized SO_3 is employed. Air is employed as diluent for SO_3, and the gaseous mixture is passed through the liquid hydrocarbon at 45 C to 55 C. Several variants are possible for this technique. Thus, the air may be introduced on a once-through basis, or the bulk of exit air may be recirculated to utilize the (small) amount of contained SO_3. In each case, the amount of SO_3 introduced into the hydrocarbon phase is slightly in excess of stoichiometric requirements. Total reaction time is 2.5 to 3.5 hours, depending largely on the efficacy of cooling provided in the conversion equipment.

The quality of alkylate differs; and the same sulfonation process, applied to different feed stocks, results in products of different quality, notably in point of meeting color specifications. Dodecyl benzenes which yield a product of inferior color when sulfonated directly with SO_3 can reportedly[3] be treated more advantageously by introducing a heel of 96% sulfuric acid with the charge. The amount of heel is less than 10% based on the hydrocarbon. According to Carlson, the use of a sulfuric-acid heel can lead to substantial improvement in product color, but it does lead to a product which contains more inorganic material.

The following product analyses are reported as typical in the sulfonation of dodecyl benzene by means of anhydrous SO_3:

	Without Heel	*With Heel*
Free oil, % of active (pure sodium sulfonate)	1.4	1.4
Na_2SO_4, % of active	3.4	12.4
Klett color—the lower the number, the better the color	95	75

Thus, sulfonation by SO_3 ojers a route to grades of dodecyl benzene sulfonate which cannot be produced by more conventional techniques. The low attainable sodium-sulfate content opens new markets to the product and helps it meet the competition of newer-type detergents in fields in which low concentration of inorganic salts is critical.

IX. Production of Polypropylene—

For nearly four years, polypropylene has been generally hailed as the next major plastic product. Yet, its commercial production in the United States did not begin until December 1957, when Hercules Powder Co. began operating its Parlin, N.J., polypropylene unit with initial capacity of 20 million pounds per year.

By late August 1958, Hercules indicated that it is considering plans for early expansion of its polypropylene capacity. During the same month, Humble Oil Co. announced plans to enter the polypropylene business with a 40-million-pound-per-year plant to be taken onstream by early 1960 at Baytown, Texas.

Worldwide, there are today three polypropylene plants in operation. In addition, three polypropylene units and one ethylene-propylene copolymer plant are under construction. Following is the line-up of propylene polymerization units which are either in existence or under construction at this time:

United States	*Capacity after Announced Expansion (Millions of Pounds Per Year)*	*Product*
Hercules, Parlin, N.J.	20	Polypropylene
Humble, Baytown, Texas	40	"
Germany		
Hoechst	17	"
Italy		
Montecatini	44	"
Montecatini	135	Propylene-ethylene copolymer
Austria		
Danubia Petrochemie Montecatini-Stickstoffwerke	11	Polypropylene
Japan		
Nissan Chemical Ind.	10	"

(Continued on page 102)

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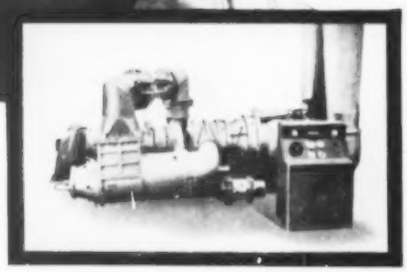

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Exploratory work in the polypropylene field is being carried out by numerous other manufacturers, among them the following USA firms: Bakelite Division, DuPont's Polychemicals Department; Minnesota Mining and Manufacturing Co.; Goodrich-Gulf Chemicals Co.; Amoco Chemicals Corp.; Phillips Petroleum Co.; Tennessee Eastman Co.; Sun Oil Co., and others.

Several factors combine to make polypropylene so widely attractive as a direction for future growth. First of all, is the low raw-materials cost. Second is the great versatility of the product, whose properties can be varied over a wide range by variation in the catalyst system (see below). Third is the accumulation of know-how, both in the synthesis of polypropylene and of linear polyethylene which can be produced by essentially similar methods. Finally, there is the possibility of adapting low-pressure polyethylene plants to polypropylene synthesis if the future market should so warrant.

Not all major problems have been satisfactorily solved in the production of a widely marketable polypropylene. On the technical side, a key problem is the choice of a stabilizing agent for the product which, uninhibited, is oxidized too readily. *Modern Plastics*[4] reports that Hercules uses various stabilizers for different material grades, such as electrical, thermal, outdoor durability, and food. Often, one desirable characteristic (such as low color) may have to be sacrificed to achieve a more essential goal (e.g., low toxicity for food applications).

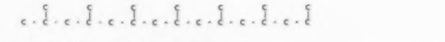
The legal situation concerning polypropylene is extremely complex; several hundred patents and applications are on file. Much of the work follows along the lines of low-pressure polyethylene synthesis. The emphasis is on catalyst systems based on aluminum alkyls, promoted by heavy metal chlorides. Use of these catalysts are largely due to Ziegler, in Germany, and to Montecatini's Natta in Italy.

The outstanding characteristic of catalyst systems in this category is their ability to direct the formation of polymers according to a predetermined geometrical pattern. The use of such "stereospecific" catalysts permits the manufacture of polymers which range from the completely amorphous state to a highly crystalline product. Here, a brief explanation is in order.

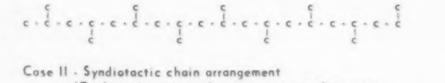
Polymeric macromolecules are built up from a large number of repetitive units—the monomer. The character of the product is determined by the number and geometrical arrangement of the monomers within the polymer molecule.

When the monomer is completely symmetrical, as is the case for example with ethylene, a linear chain can be formed in only one fashion—each monomer molecule assuming the same geometrical position. (Note, however, that different degrees of chain branching are possible. Polyethylene produced by low-pressure techniques is essentially linear.)

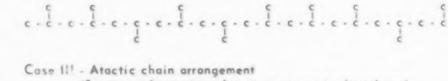
The majority of monomers, however, are quite unsymmetrical, and innumerable special arrangements become possible. In the case of propylene, for example, the chain may be built up by any of the following patterns:



Case I - Isotactic chain arrangement
(Each tertiary atom shows the same steric configuration)



Case II - Syndiotactic chain arrangement
(Each tertiary atom shows a steric configuration opposed to that of its neighbors)



Case III - Atactic chain arrangement
(Steric configuration of tertiary atoms is distributed in completely random fashion)

Before stereospecific catalysts were discovered, the polymerization of unsymmetrical alpha-olefins (such as propylene) could yield only the atactic polymer, i.e., a molecule in which the monomers are geometrically arranged in completely random fashion. This type of polymer is amorphous and is not suitable for production of plastics or fibers. Atactic polymers of very high molecular weight are, however, a basis for the production of synthetic elastomers (e.g., synthetic types of rubber).

As the geometrical symmetry and the linearity of a polymer increase, the product becomes increasingly crystalline. Natta[5] points out that the properties connected with such crystallinity determine the most interesting properties of the polymer, viz., its hardness, its mechanical properties, its molding characteristics, its melting temperature, and the ability to yield high-tenacity fibers.

The work with polypropylene has been directed primarily toward the production of linear *isotactic* polymers. It must be understood that the product obtained under present commercial conditions is not solely of one or the other geometric type, but that the desired steroisomer can be made to predominate in varying degree.

With these techniques of stereospecific polymerization, a new dimension is thus given to the field or polymer production. The product's properties may be adjusted to a desired purpose by controlling not only the molecular weight and its linearity, but also by controlling the geometrical arrangement of the monomer units within the polymer molecule to almost any needed degree of symmetry.

The formation of a linear polymer of ethylene has been shown by Ziegler to take place in the presence of aluminum alkyl or lithium alkyl catalyst. This catalyst may be modified by the addition of small quantities if transition metal compounds, and will then lead to the formation of linear polyethylene of very high molecular weight.

Natta[5] points out that the production of crystalline polymers from other alpha-olefins (such as propylene) requires a catalyst system in which an asymmetric metal alkyl complex is part of a *solid* surface. It is necessary that the catalyst itself show the right type of crystallinity. For example, hexagonal titanium trichloride produces highly crystalline polymers. Titanium trichloride formed by reducing $TiCl^4$ with an equimolar quantity of triethyl aluminum has a different crystalline structure; it leads to a less crystalline polymer (about 60% stereospecific). Finally, titanium chloride obtained by reduction with a greater quantity of triethyl aluminum is only about 35% to 40% stereospecific.

The reaction rate is proportional to the partial pressure of monomer. A practical rate is achieved in the range of 1 to 3 atmospheres and 70 C.

The effect of temperature on reaction rate is similarly pronounced. At 70 C, the rate is about twice that at 55 C. Natta reports that the temperature has little effect on the product's molecular weight at low temperature, but that a strong effect is noted above 100 C. At these higher temperatures, the stereospecificity is also greatly decreased.

With the ability to vary the degree of the product's crystallinity, a tool is provided to obtain, from a single monomer, polymerization products whose properties cover the range from rubber (which is essentially amorphous, except for crystallinity introduced by vulcanization) to fibers whose molecules must be completely linear, of high molecular weight, and of pronounced stereospecificity (in the case of the simple monomers).

Intermediate between these two extremes is a whole range of plastic products with widely differing properties. The initial production and marketing effort is directed to a few products in this field.

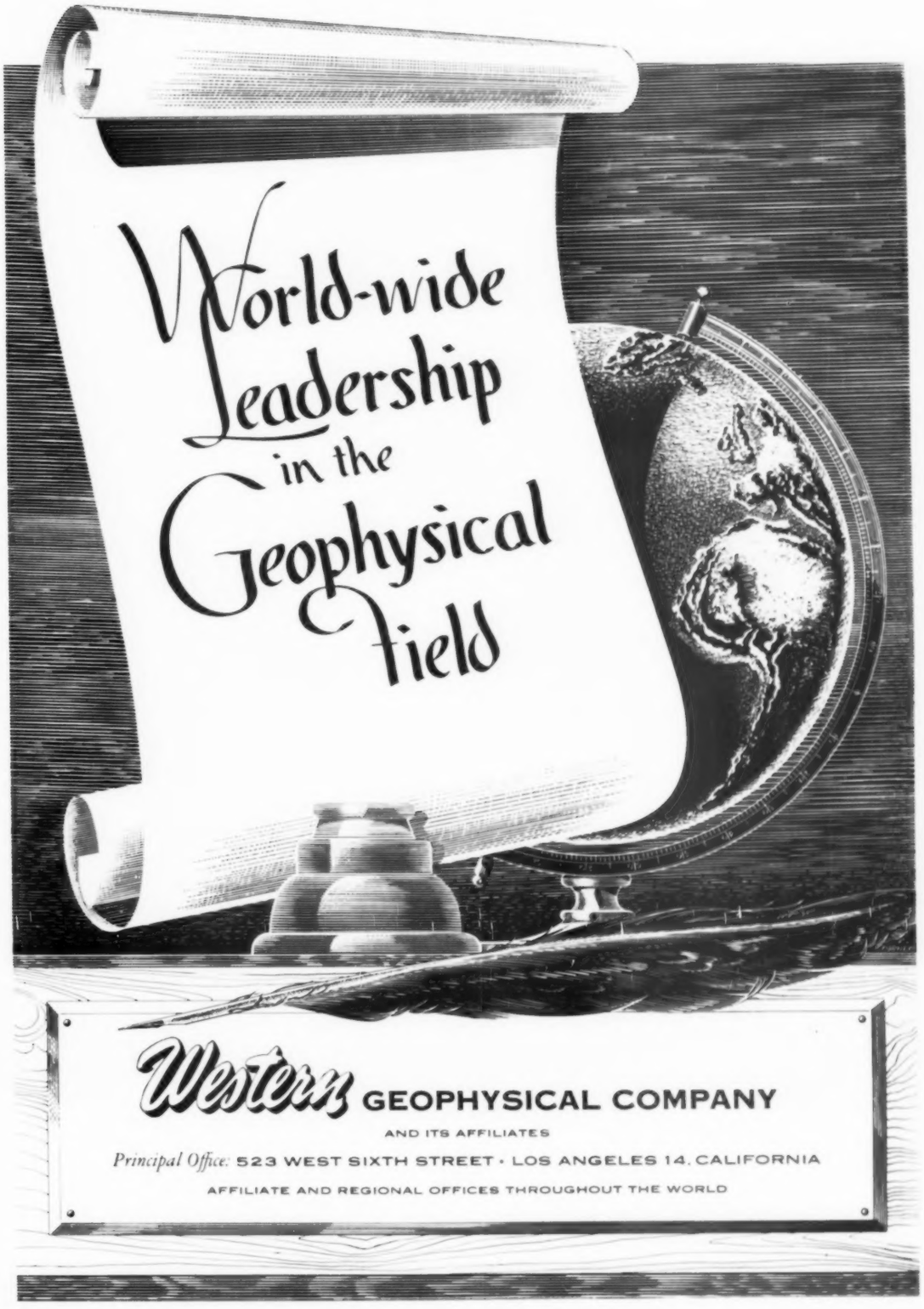
The full scope of applications for polypropylene plastics cannot be foreseen at the present early stage of its development. But there are many good reasons for the widely held optimism in this field. For one thing, propylene is the cheapest of any known monomer, and this augurs favorably for the long-range price of its polymerization products.

Beyond this, polypropylene plastics have outstanding physical, chemical, and electrical properties. The melting point is above 140 C; and derived products are, therefore, suitable for uses which call for sterilization. Furthermore, the material is characterized by high inherent strength, chemical inertness, fine detail, surface hardness, high gloss, good colorability and rigidity.[6]

High electrical strength and resistance, and the low vapor pickup of polypropylene, make it suitable for use in electrical insulation and molded parts for the electronic industries.

Ottolenghi[6] looks to eventual large-scale use in pipes, fittings, sheets, transparent films, and in household articles, automotive parts, toys, and a host of other products where its good physical qualities will serve. The product is readily extruded or molded, and is susceptible to film production by

(Continued on page 106)



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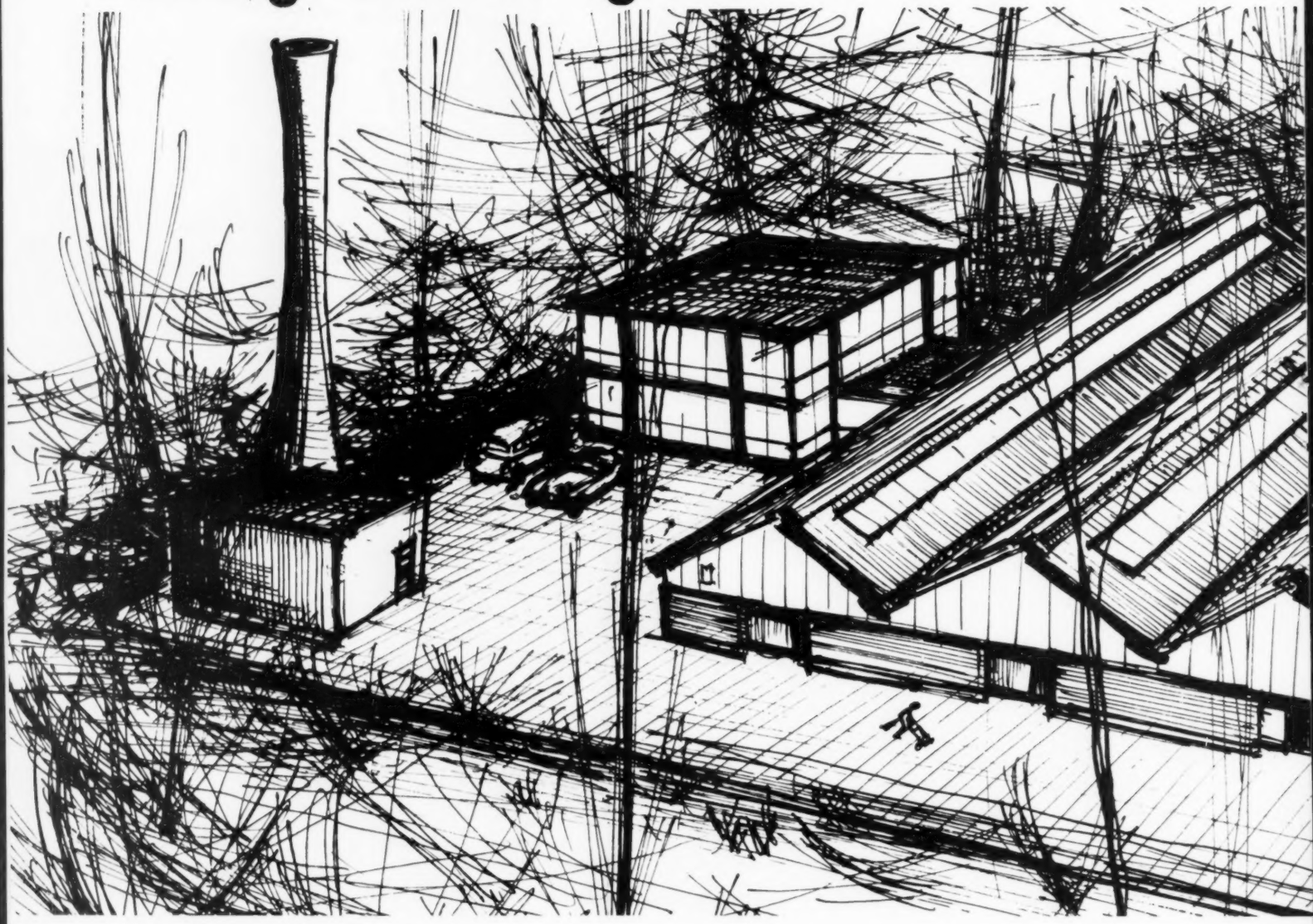

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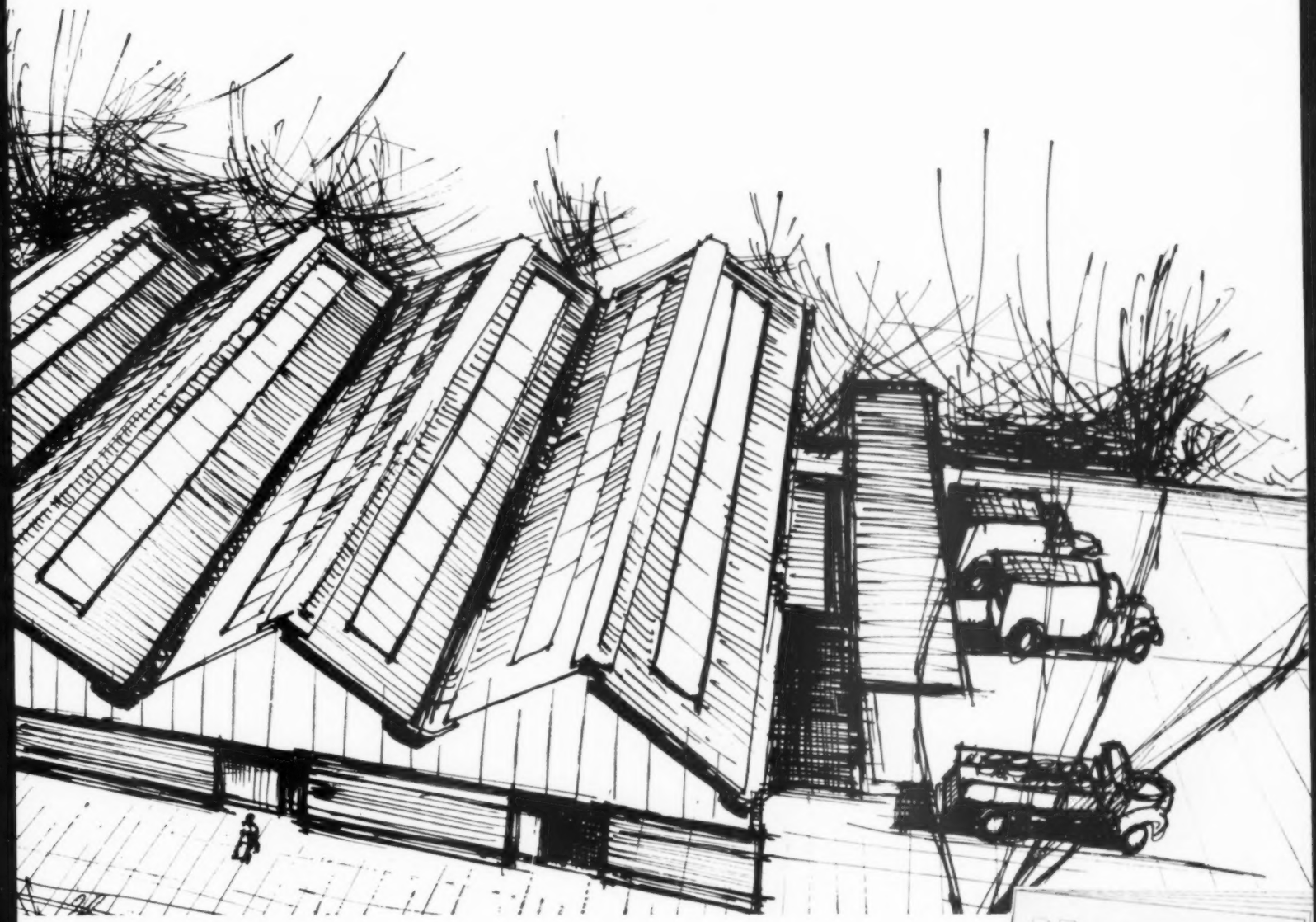

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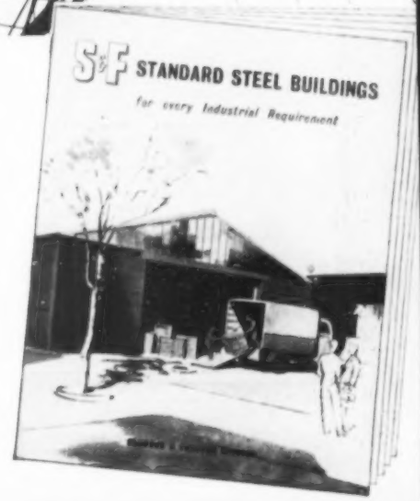

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Petrochemical Horizons for Propylene

(*Continued from page 102*)

widely practiced techniques. Finally, polypropylene products can be readily lathed, milled, drilled, blown, and machined.

In conclusion, then, propylene appears to be at the outset of a major growth era in chemical applications, with the greatest promise shown by polymers of the stereospecific polypropylene and polypropylene-oxide types, and with further important utilization (of propylene oxide) in polyurethane products.

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Shell Chemical Reorganization

Effective January 1, Shell Chemical Corp. formed four additional fully integrated divisions, bringing total of these to five. New agricultural chemical division will be headed by Sumner H. McAllister; ammonia division by Lawrence M. Roberts; industrial chemicals by Alfred W. Fleer; plastic and resins by Martin Buck; synthetic rubber by John P. Cunningham. Head office in New York will be concerned mainly with matters involving more than one division or of interest to company as a whole.

Present vice presidents include Cecil W. Humphreys and George R. Monkhouse. With retirement of Leo V. Steck, two new vice presidents have been added: Bernard M. Downey and George W. Huldrum, Jr.

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Phelps Dodge Copper Products Corp.
Pierce Construction Co.
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INTERNATIONAL NEWS AND NOTES

Syrian Settlement With IPC

Iraq Petroleum Co. has announced it has reached agreement with the Syrian government on the revision of payments under its 1931 convention in respect of the company's pipeline and terminal operations in Syria. The agreement reached in Damascus, November 26, 1958, will give the Syrian government a revenue of some £6,500,000 sterling (US $18.2 million) on the expected rate of throughput of approximately 26 million tons (about 520,000 b/d) during 1956. The sum of £6,500,000 is made up of payments of 1/4d (one shilling and four pence) per hundred ton-miles for the distance traversed through Syrian territory, and 1/1d (one shilling and one penny) per ton on the terminal throughput. These payments, amounting to £6,000,000, are in fact equivalent to 50% of the calculated profit on the pipeline and terminal operations in Syria. In addition, there are port dues and security payments amounting to £500,000 per annum. The company also agree to pay Syria the sum of £8,500,000 (US $23.8 million) in settlement of all outstanding claims between the two parties.

Algerian Completions

CFPA-SN Repal at Hassi Hessaoud oil field completed 18 wells up to December 12, 1958—17 oil producers, one observation. Fifteen rigs are drilling —11 heavy deep-drilling, two medium and two light rigs. Twelve deep wells are drilling.

In November 1958, crude delivered to SOPEG (joint transport company) amounted to 49,941 cubic meters. Daily average in November was 1,665 cubic meters. Since December 1957, 446,482 cubic meters of crude have been delivered from Hassi Messaoud field. Two wells for each company are in production.

Work on the new 24-in. pipeline to Bougie is in progress. Pipe laying has started, and work is proceeding on four pumping stations, the tank farm, and berth at Bougie terminal.

At the Hassi er R'Mel field, seven wells have been completed—all producing wet gas. One drilling rig is working on HR. 8, which has reached 2,336 meters in Cambro-Ordovician clays.

Algerian Discovery

A new oil well in eastern Sahara recently was announced by CREPS in its eastern division, some 25 miles southwest of Edjele. Oil was found in the Ordovician layers. The well, Ouan Taredert No. 1, was a test at 1,500 meters, yielding 6,000 liters per hour with bottom-hole pressure at 161 kg per square centimeter. Drilling went to 1,672.70 meters; $4\frac{1}{2}$-in. casing was cemented at 1,540 meters for production from the oil-bearing formation.

BP Plant Construction Begun

Ground was broken on November 18 for the new refinery to be built by British Petroleum in the Ruhr area of Germany. The new refinery to be built on a 600-acre site near Dinslaken, some 15 miles north of Duisburg, will have a throughput capacity of 4,400,000 tons a year (100,000 b/d). Site clearance has started, and the refinery is due to be completed before the autumn of 1960.

The main processing plants in the refinery will be two crude-oil distillation units, a catalytic reforming unit, a hydrofiner for desulfurizing gas oil, and two copper-chloride units. A wide range of products will include the highest grade motor spirits, aviation turbine fuels, marine diesel oils, gas oils, fuel oils, and chemical works feed stocks. The petroleum chemical feed stocks will be supplied to new units being built for Erdoelchemie-GmbH, a joint company established by BP's German associate, BP Benzin und Petroleum AG, and Farbenfabriken Bayer AG. Crude oil for the new refinery will be drawn from the Wilhelmshaven-Ruhr pipeline at present under construction. Some products will be distributed in Rhine barges for which a harbor is to be built at the junction of the Rhine and the Lippe Seiten Canal about three miles from the refinery. Other products will leave the refinery by road and rail.

Australian Oil Hunt

Another USA independent, Santiago Petroleum Corp., subsidiary of Pan-Israel Oil Co. Inc. and Israel-Mediterranean Petroleum Inc., has announced the acquisition of 3,200,000 acres of petroleum concessions in the Great Artesian Basin of Queensland, Australia. Santiago's interest is 75%; 25% is held by Central Queensland Petroleum Ltd., an Australian company. Santiago also has applications for an additional 22,400,000 acres in central Queensland.

Stanvac In Australia

Standard-Vacuum, through its wholly owned Australian subsidiary, Vacuum Oil Co. Pty. Ltd., has joined other interests to search for oil on a 110,000-square-mile concession in South Australia and Queensland. The venture is scheduled to include the drilling of three wells in 1959-60, one of which may go as deep as 14,000 ft. Participants are Delhi Australian Petroleum Ltd., Santos Ltd., and Frome-Broken Hill Pty. Ltd.

Persian Gulf Terminals

Raymond International Inc. has been awarded two contracts for oil-loading facilities in the Gulf of Arabia (Persian Gulf), one offshore from Iraq and the other offshore from Iran.

The Iraq project will be a deep-water island tanker berth to accommodate supertankers from Basrah Petroleum Co., and will cost in excess of $12 million. To be known as the Khor-Al-Amaya deep-water tanker berth, it is located 25 miles offshore from Fao, Iraq.

The Iran project is a fuel-oil loading steel jetty and boat harbor for the new oil-loading terminal on Kharg Island, which is part of the Gach-Kharg

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project being developed by a consortium called the Iranium Oil Exploration and Producing Co. The undertaking derived its name from the Gach Island field near the northeast shore of the Gulf of Arabia (Persian Gulf) and Kharg Island which is 23 miles offshore from Iran. The estimated total cost of the jetty and boat harbor is $5 million. Raymond is also a partner in the management contract for the entire development estimated to cost $60 million.

Joint Venture In Israel

Denver-Golden Oil and Uranium Co. has concluded arrangements for a drilling program on petroleum properties in Israel which are held under license by Pan-Israel Oil Co. Inc. and Israel-Mediterranean Petroleum Inc. Denver-Golden was scheduled to drill a shallow test well on the Kurnub structure in the Negev Desert in January. Denver-Golden has committed itself only for the drilling of one test well, for which it earns a 10% working interest in the 80,000-acre concession, but has option rights to drill an additional four test wells to earn up to a 50%. Denver-Golden is the operator of the Schwartzwalder pitchblende uranium mine near Denver, one of the highest-grade uranium producers in the United States.

Turkish Refinery Financing

Head of Jamaica Oil & Chemical Co. (BWI) is to speak with USA and French interests concerning financing of projected $18 million refinery at Istanbul, approved by Turkish government. Operator will be called Turish American Oil Co.

Turkish Acquisitions

Acquisition of oil concessions in Turkey amounting to nearly a million acres has been announced by Pan American Land & Oil Royalty Co.—including 187,740 acres in District V and 481,372 in District VI, southeastern Turkey; and 244,131 in District III, western Turkey.

USSR Asphalt Discovery

The discovery in the oil-producing region of Kazakhstan of a large asphalt lake having a bitumen content of 95% was recently reported from Moscow. Since the bitumen is more liquid than that of other asphalt lakes, it can be used for cold asphalting. The lake has not been discovered earlier because of a sand crust which covered it, the report said.

Indian Refinery Aid

Italians in India recently were studying the feasibility of Italian participation in a proposed 40,000 b/d refinery by the Indian government in Bihar.

German Line Gets Crude

First two tanker loads of oil for the new 220-mile 28-in. pipeline to the Ruhr arrived recently in Wilhelmshaven, Germany, with Iranian and Venezuelan crude.

Somalian Survey

Spartan Air Services (Eastern) Ltd., of Nairobi, Kenya, a subsidiary of Spartan Air Services Ltd. of Ottawa, Canada, has started on an airborne survey of a large portion of Somalia, East Africa, for Frobisher Ltd., of Toronto. Frobisher has acquired an oil exploration license for 70,000 square miles in the south of Somalia, and 8,000 square miles in the north of Kenya. Total area is said to be one of the largest, unexplored sedimentary and possible oil-bearing areas in the world.

Mobil's Turkish Test

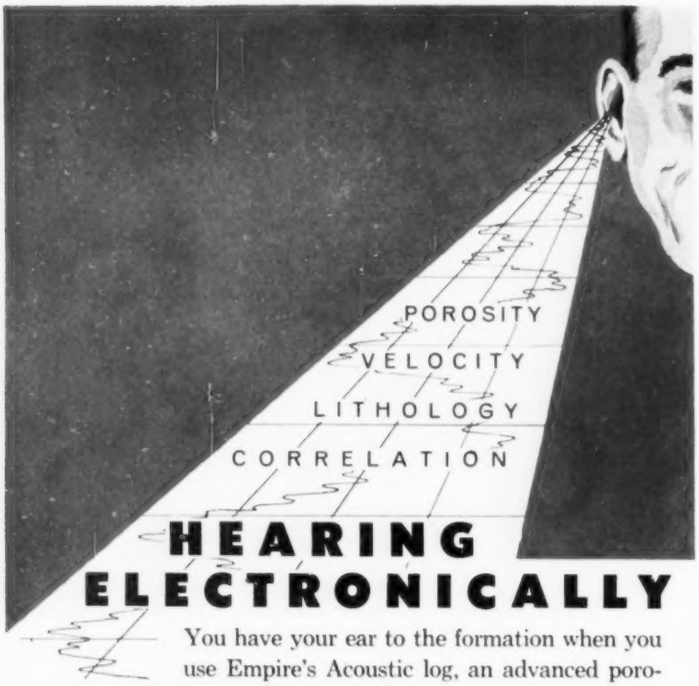
Mobil Exploration Mediterranean Inc., holder of largest oil concession in the Adana area of Turkey, spudded in its first test well in the country near Kuransa, about 20 miles south of Adana, December 2. Sea Cat Drilling Co., the contractor, says rig is capable of going to 20,000 ft, but that Mobil plans to stop at 15,000 ft. Drilling should be relatively simple, says Sea Cat, completed in three months. The company said testing and coring operations will require at least another three months.

Austrian OeMV In 1958

In view of the declining crude production in Austria—down to an estimated 2.85 million tons from 3.04 million tons in 1957—the State company OeMV, which produces about 95% of the crude output, intensified its search for oil by stressing geophysical work. At a cost of $1.5 million, OeMV had 11 geophysical crews (8 seismic, 1 gravimetric, 1 telluric, 1 geoelectric) in the field, 4 of which were company-owned. OeMV's old Russian refraction device and its 2 modern (Southwestern Industrial Electronics Corp.) USA seismic reflection devices were in operation in the Marchfeld, Laa, and Tulln areas. Five seismic crews were hired from the German firm PRAKIA, one of which carried out surveys in the OeMV-BP concession areas of Scheibbs and Amstetten. OeMV's gravimetric crew with Askania equipment was active in the Tulln and Marchfeld areas; telluric work, applied for the first time in Austria, was carried out by Cia. Generale di Geofisica, Italy, in Kilb, Laa, Hollabrunn, Vienna Basin, and Amstetten. Geoelectrical surveys were carried out in Tulln. The geophysical work is said to have led to the indication of some favorable locations for future drilling activity.

Of OeMV's drilling rigs, 25 were in operation. During 1958, two USA (Cardwell L-359) and one Austrian (Mannesmann Trauzl R-33-V) drilling rigs were bought.

Thirteen exploratory wells, with 81,562 linear feet (1957: 11,235 ft) were brought down at Strasshof, Kagran, Pyrawarth, Spannberg, Rabensburg, Rutzendorf, Raasdorf, Aderklaa, Mank, and Moosbierbaum. Ten structural tests were drilled at Hohenau with 24,214 ft (1957: 18 tests with 35,356 ft). Only 45 production wells with 236,117 ft were drilled in the fields of Matzen, Blockfliess, Muehlberg, Schoenkirchen, and Zwerndorf, compared with 112 production wells with 518,224 ft in 1957. Thirteen extension wells with 78,744 ft (1957: 9 with 56,230 ft) were drilled at Bockfliess, Matzen, Spannberg, and Raggendorf. The hoped-for oil strike which would serve as a substitute for the declining Matzen oil field did not occur.



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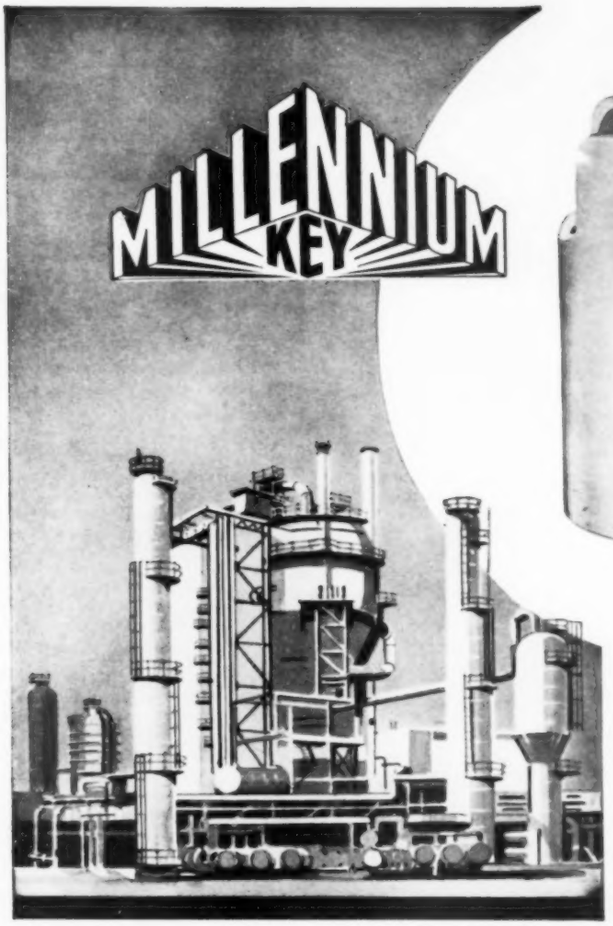

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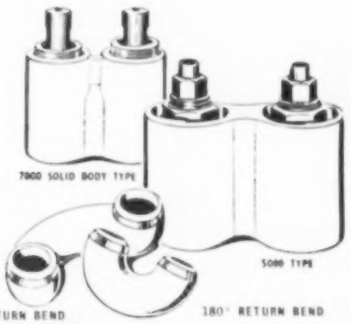

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J. KEITH MILLER has been appointed manager of the land department for all divisions of King-Stevenson Oil Co., Chicago oil and gas exploration and development firm. Mr. Miller, formerly with the land department of Pan American Petroleum Corp., will make his headquarters in Oklahoma City.

G. E. G. HOPE-JOHNSTONE has been appointed executive representative of McColl-Frontenac Oil Co. Ltd., to carry out special assignments. Formerly he was vice president of Regent Refining (Canada) Ltd., a McColl-Frontenac subsidiary.

FRANK W. BOWEN has been appointed assistant to Clarence H. Thayer, the vice president in charge of manufacturing for Sun Oil Co., Philadelphia. Mr. Bowen succeeds W. Henry Linton, retired after 40 years of service. Mr. Bowen started with Sun Oil in 1939, and has served at the company's Toledo, Ohio, and Sarnia, Ontario, refineries. He was refinery engineer at Sun's Marcus Hook refinery prior to his current appointment.

LEONARD L. HUXTABLE has been named manager of the western region of the sales department of Ethyl Corp. at Los Angeles, to succeed Meredith Littlefield, who has been granted a leave of absence. Mr. Huxtable has been assistant manager of the southern region, with headquarters in Tulsa, since 1955. J. O. Balzer was named to succeed Mr. Huxtable as assistant manager of the southern region, and J. E. Hendrick succeeds Mr. Balzer as district manager of the Houston office.

MARTIN A. McNULTY, who rose from office boy to comptroller of Standard Oil Co. (Ind.), retired February 1 because of illness, after 43 years' service. William A. Underwood was promoted from assistant comptroller to succeed him.

RICHARD A. NY has been elected treasurer of Tidewater Oil Co., with headquarters at the company's home office in Los Angeles, Calif. He succeeds Russell D. Richardson, who continues as vice president-finance and controller.

J. K. Miller

D. A. Shepard

DAVID A. SHEPARD, a director of Standard Oil Co. (New Jersey), has been elected an executive vice president and a member of the executive committee. He began his 31-year association with the Jersey Standard organization in 1927 and has been a member of the board since 1951 after wide experience with the company's domestic and foreign affiliates.

V. W. MEYTHALER has been elected vice president and treasurer of Texas Gas Transmission Corp., Owensboro, Ky. He formerly was treasurer of the company.

DON W. DETJEN has been named executive assistant to the management of Valvoline Oil Co., Freedom, Pa., a division of Ashland Oil & Refining Co., Ashland, Ky.

J. W. (Bill) CARNEAL, has been appointed director of sales and industrial development for Texas Gas Transmission Corp., Owensboro, Ky.

G. L. GARDINER, general assistant to the vice president-manufacturing, Shell Oil Co. of Canada Ltd., has retired after 31 years with the company. Coming to America in 1928 from London, he held various assignments at Shell's Martinez (Calif.) refinery and in the company's San Francisco office. In 1942, he was appointed manager of Shellburn Vancouver refinery, and in 1956 he moved to the company's head office in Toronto.

CHARLES K. BELL

Charles Kenneth Bell, assistant secretary and assistant treasurer of Reed Roller Bit Co., has suffered a fatal heart attack. He was 48, and had been with Reed for 18 years. Mr. Bell had returned to his job recently after having been first hospitalized for a heart attack last October. A lifelong resident of Houston, he joined Reed Roller Bit in 1939.

C. E. McCLURE

C. E. McClure, vice president of Lorac Service Corp., a subsidiary of Seismograph Service Corp., Tulsa, died January 4, at Marathon Key, Fla. Mr. McClure died while supervising the installation of an East Coast Lorac network for his company.

JOSEPH F. ADAMS

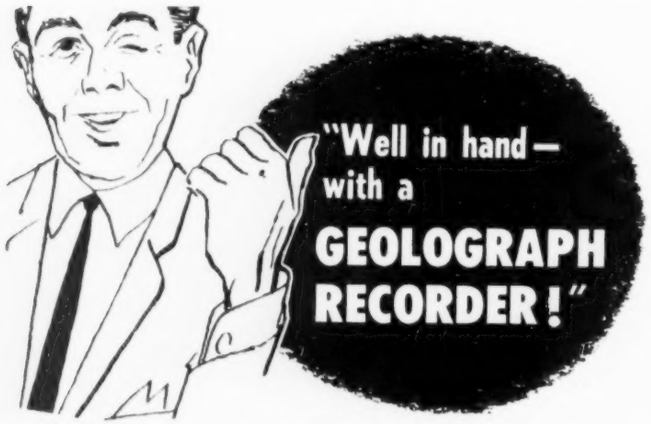
JOSEPH F. ADAMS, a pioneer consultant in the petroleum industry, died, December 10, 1958, at his home in Wilmington, N.C. Mr. Adams, 65, was a native of Houston, Texas. He entered the oil industry in 1915 with Barnsdall Refining Co. and later became a vice president of Wadhams Oil, Milwaukee. In recent years, he was associated with Bowser & Co. and Continental Can Co., New York. From 1937 to 1944, he was an executive of Owens-Illinois Can Co., in Toledo.

HOWARD G. TEXTER

HOWARD G. TEXTER, authority on oil-country tubular goods, died December 27, 1958, at Chapala, Jalisco, Mexico. He was 68 years old. Mr. Texter joined the Spang-Chalfant Division of National Supply Co. as a metallurgist in 1923. From 1943 until his retirement in 1957, he held the position of chief field engineer for the division.

HENRY LEFEBVRE

Henry Lefebvre, advertising manager of Avondale Marine Ways Inc., in New Orleans, died January 6, 1959, after a lengthy illness.



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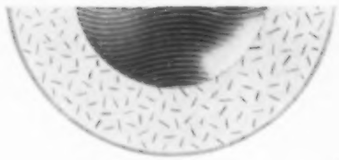

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Proudfit New Creole President

Creole Petroleum Corp. has announced the election of A. T. Proudfit as director and president to succeed H. W. Haight, who has resigned in order to accept the position of director and chairman of The Carter Oil Co., a subsidiary of Standard Oil Co. (New Jersey), with headquarters in Tulsa, Okla. Mr. Proudfit served as president of Creole Petroleum Corp. from February 1945 through November 1954, when he resigned to become a director of Standard Oil Co. (New Jersey). He has now resigned this position to return to Creole.

Rubber Plant Planned

The Firestone Tire & Rubber Co. will build the world's first plant for the production of synthetic Diene and Coral rubbers. Diene is a partial replacement for natural rubber, and Coral is a complete replacement. The new plant will have an annual capacity of 30,000 tons. It will be an addition to the company's petrochemical center in Orange, Texas.

Phillips Foreign Sales

A foreign sales and development department is being formed by Phillips Petroleum Co., to be headquartered in New York, with John Getgood as manager. The new department initially will engage in worldwide sale of crude oil.

AAODC Executive V.P.

The appointment of Warren L. Baker as executive vice president of American Assn. of Oilwell Drilling Contractors, effective February 1, was announced by Joe Zeppa, president of Delta Drilling Co., Tyler, Texas, newly elected president of the AAODC. In this position, Mr. Baker will head the association's staff in Dallas, in the Insuromedic Life Building.

In assuming his new duties, Mr. Baker resigned his positions as vice president and director of Gulf Publishing Co., and also as editorial director of two of the company's oil publications, in Houston. He has been a news, feature, and editorial writer on economic, political, and technical developments of the petroleum industry since 1923, and is a frequent speaker at oil-industry meetings. The API Houston Chapter honored him two years ago with the first "Meritorious Service Award" ever presented by the chapter.

Mr. Baker succeeds Brad Mills, executive vice president of the association since its inception in 1941, who is retiring.

Hardin GCAGS President

GEORGE C. HARDIN, Jr., exploration and production manager for the Michel T. Halbouty oil and gas interests, and executive vice president of the Halbouty Alaska Oil Co., has been elected president of the Gulf Coast Assn. of Geological Societies. Other newly elected officers are Lyle H. Harvey of New Orleans (John W. Mecom), vice president; Weldon C. Henkhaus of San Antonio (Arkansas Fuel Oil Corp.), secretary; and James A. Wheeler, consulting geologist of Houston, treasurer.

1,500 Miles Of New Pipeline

Approximately 1,500 miles of pipeline, ranging in size from 8-in. to 55-in., were completed by Williams Brothers, worldwide construction and pipeline firm, during 1958. The pipelines were located in nearly a dozen countries in addition to the United States and Canada.

This announcement is neither an offer to sell nor a solicitation of an offer to buy these securities. The offer is made only by the Prospectus.

2,900,000 Shares

Universal Oil Processes, Inc.

(Name to be changed to Universal Oil Products Company)

Capital Stock

(Par Value $1 Per Share)

Price $25 per Share

Copies of the Prospectus may be obtained in any State only from such of the several Underwriters, including the undersigned, as may lawfully offer the securities in such State.

Lehman Brothers

Smith, Barney & Co.

Merrill Lynch, Pierce, Fenner & Smith
Incorporated

February 5, 1959.

Floating drill platform off coast of Trinidad.

Floating Drill Platform

Dominion Oil Ltd. has been drilling exploratory wells in the Gulf of Paria, off the west coast of Trinidad, for more than a year using a floating platform—with steadily increasing efficiency. Although the speed of drilling the hole has not been spectacular in comparison with conventional methods, drilling costs have now been reduced until they are comparable with land drilling costs, and several holes have exceeded the widely advertised depth records for this method of drilling. One hole reached a depth of 10,184 ft before abandonment for geological reasons, and the rig is currently drilling a $9^7/_8$-in. hole below 9,000 ft.

In June 1957, Dominion Oil Ltd. agreed with its parent company that Socal's success with the "Western Explorer" off the coast of California had been sufficient to justify the use of a similar vessel for drilling medium-depth exploratory slim holes in the Gulf of Paria. The Offshore Co., of Baton Rouge, La., was selected as the drilling contractor. The latter's 240-ft x 72-ft x 15-ft barge was equipped with six 6,000-lb Danforth anchors, two cranes, blowout-preventer hose reel, constant-tension devices for the submarine guide lines, and a 12-ft-diameter well was cut in the center of the barge. After the barge had been towed from New Orleans to Trinidad, a National 55 consolidated rig was installed. The 131-ft Lee C. Moore mast was shortened to 100 ft, and provision made to lay the $3^1/_2$-in. drill pipe down in doubles. A gimballed rotary bushing was used, block guide cables were installed, and the barge was ready for its first location in September 1957. Shaffer submarine drilling equipment has been used since the beginning of the program.

The drilling program and the equipment have been constantly modified and improved to suit conditions in the Gulf of Paria. The mast has been lengthened to the original 131 ft and reinforced in order to stand back all the drill pipe in trebles, and $4^1/_2$-in. drill pipe is being used to drill conventional-size holes. A drill nipple has been added with the necessary motion-compensating devices, and block guide rails have replaced the original cables. The constant-tension devices are rarely used, although they are still installed.

Holes have been drilled in water depths ranging from 36 ft to 106 ft, and weather conditions have ranged from dead calm to 14-ft swells. The larger swells are extremely rare, and drilling is not attempted during these periods—although other operations can continue. By using additional bumper subs in the drill string and a recently designed drilling nipple soon to be installed, Dominion hopes to continue drilling in at least 10-ft swells.

All operations are affected to some extent by the

constant moving of the barge and drilling equipment with respect to the hole being drilled. A self-actuating compensating device has been installed to keep wire-line tools stationary with respect to the hole.

Three successful fishing and washover jobs have been completed to date without undue difficulty due to barge movement. As much as 5,000 ft of 4½-in. drill pipe and 7-in. drill collars were washed over and recovered in five doys on one occasion. Both Dominion Oil Ltd. and Offshore Co. have shown considerable engineering ingenuity in the way they have solved the may unique problems encountered in this entire operation. In addition, it is not possible to use some special tools (such as tension-operated outside cutters), and tool selection must always be made considering the complications due to movement.

Dominion has not as yet had an opportunity to test or complete a well, but Dominion operating personnel are prepared to do so should the occasion arise. They feel that testing operations can be simply and successfully conducted, but completion of a well for production under these circumstances will introduce many new and varied complications. These problems have not as yet been solved to the extent that the method could be satisfactorily used to drill development wells.

Moscow On Origin Of Oil

At a conference on the origin of oil and natural gas, recently held in Moscow, Leningrad geologist Dr. Nikolai Kudryavdzev and Ukrainian Professor Vladimir Porfiryev propounded a new theory on the inorganic origin of oil.

Both scientists assume that oil originated in "magmatic" zones of the earth where it was formed inorganically or existed as a cosmic substance. Later it migrated through cracks in crystalline rock and accumulated in porous and permeable strata and in alluvia.

After a lively discussion with the advocates of the organic origin of oil, Dr. Natalya Uspenskaya suggested a compromise that the formation and accumulation of hydrocarbons occur in alluvia, although the successive stages in the process are not quite clear. On the other hand, she said, the cosmic origin of hydrocarbons and the existence in the earth's crust of hydrocarbons of magmatogenous origin are also beyond doubt. To prove her point, she referred to the number of minerals such as iron and the ores of many metals which have, as is generally agreed, a biogenous and a magmatogenous origin.

Finally, the conference came to the conclusion that an inorganic origin of hydrocarbons at great depths is possible; the question of whether such hydrocarbons can form industrially exploitable pools remained open.

Drilling-Mud History

History and evolution of drilling mud is described in an article titled "Our Business is Drilling Mud," in the November-December 1958 issue of *The Magco Scene*, house magazine of Magnet Cove Barium Corp., one of the Dresser Industries, Houston 5, Texas.

NYC Office For Kerr-McGee

A New York City office has been opened by Kerr-McGee Oil Industries Inc., of Oklahoma City, with C. J. Colby as manager. The office is located at 610 Fifth Avenue. A substantial portion of Mr. Colby's time will be devoted to foreign drilling contracts and other related phases of Kerr-McGee's operations. Formerly director of purchases in the company's home office, Mr. Colby has been manager of marine construction for the past several years at Kerr-McGee's Pascagoula and New Orleans offices.

Upton New Executive VP of TRECO

Edward W. Upton, veteran oil executive, has been named executive vice president of The Refinery Engineering Co., Tulsa, a division of Vitro Corp. of America. He replaces D. O. Givens, resigned.

R. H. Ray

B. McCollum

McCollum-Ray

Burton McCollum, president of McCollum Exploration Co., and Robert H. Ray, president of Robert H. Ray Geophysical Companies, have combined to form McCollum-Ray International Inc. This worldwide organization will make available the McCollum Geograph, which embraces the weight-dropping method of seismic exploration, to foreign oil operators throughout the world and to the 280 domestic oil companies operating overseas. Mr. Ray is president of the new company, and Mr. McCollum will be chairman.

This new company was formed to broaden the services offered to the petroleum industry by the individual McCollum and Ray organizations which will continue independently to serve the industry in their present capacities.

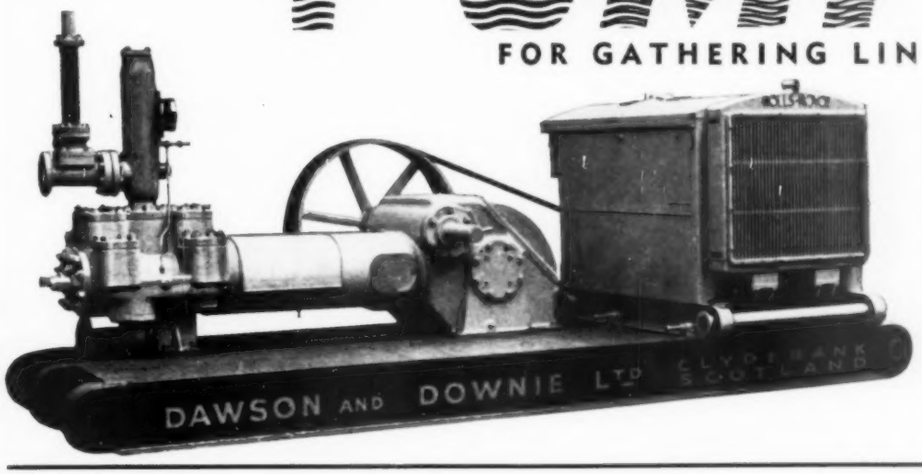
New DuPont Additive

A new additive which shows promise of reducing static hazards in a wide variety of hydrocarbon fuels and solvents by increasing the electrical conductivity of such fuels now is available for developmental testing from the DuPont Co. Known as SCA-100, the nonmetal-containing additive may prove useful in both refinery stocks and finished products where there is hazard of explosion or fire induced by static discharge. It is ashless, and compatible with other commonly used fuel additives.

OIL FIELD BLOCK STATION

PUMPS

FOR GATHERING LINES



Pressures up to 2,000 p.s.i. These pumps, available in a range of sizes, can operate in the open under all weather conditions. They are self-lubricating and sufficiently robust to withstand transporting over rough country. The liquid ends are designed so that different sizes of pistons and liners can be used, depending upon output or pressure required.

Dawson & Downie Ltd

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Halliburton Lab Manager

New manager of Halliburton Oil Well Cementing Co.'s chemical research and development laboratories is Francis Anderson. He succeeds Hayden Roberts, retired. Mr. Anderson was formerly assistant manager of the chemical research and development laboratories.

Pipeline Compressor Cylinder

Extremely high efficiency, even at compression ratios as low as 1.2, is said to be possible with a new pipeline compressor cylinder introduced by Clark Bros. Co. Division of Dresser Industries Inc. Features include new valve design utilizing nylon poppets for extra long life; large internal manifolds streamlined to avoid turbulence and pressure drop; oversize suction and discharge nozzles to keep velocities low. Fuel consumption of the new compressors is said to be unusually low, efficiency being improved 15% over previous designs.

Cummins Diesel International

Cummins Diesel International Ltd. has been established to promote the sale and service of Cummins diesel engines in international markets, according to announcement of R. E. Huthsteiner, president, and Reece Hatchitt, director-international operations, of Cummins Engine Co. Inc.

Cummins Diesel International Ltd. is headquartered in Nassau, The Bahama Islands, with additional offices soon to be opened in Europe and South America. While Cummins Diesel International Ltd. is a wholly owned subsidiary of Cummins Engine Co. Inc., it will be independently staffed and operated.

L. E. Carr, for many years manager of Cummins export distribution, has been named resident manager of the new company in Nassau. Cummins regional managers, and sales development, market development, service, and finance personnel will be based in Nassau, and the European and Latin American offices.

L. E. Carr

S. R. Hawkins

Hawkins For Ideco

S. R. Hawkins, of Florence, Italy, has been appointed technical service manager for Ideco products in Europe, Africa, and the Middle East. Ideco is one of the Dresser Industries, Dallas, Texas. Mr. Hawkins' responsibilities combine functions of technical sales consultation, engineering, and service. His headquarters will remain at the Florence plant of Nuovo Pignone, a licensed manufacturer of Ideco products, where he has been located for the past three years.

International Harvester Units

International Harvester's expanding line of International power units has been augmented with the addition of four new diesel models, the UD-554, UD-370, UD-282, and UD-236. The six-cylinder UD-554 develops 121 net horsepower at 1,800 rpm; and the four-cylinder UD-370, 80 net horsepower at the same rpm.

Ambrose Joins HOMCO

Z. C. Ambrose, of Houston, has joined Houston Oil Field Material Co. Inc. as executive vice president of HOMCO, world's largest independent oilfield service and supply company. Since 1954, Mr. Ambrose had been with Associated Oil & Gas Co. and was president of that company for the past year. He was also president of Prince Marine Drilling and Exploration Co.

Z. C. Ambrose

E. W. Upton

Treco No. 2 Man

Edward W. Upton, Tulsa, has been named executive vice president of The Refinery Engineering Co., according to President Thomas M. Lumly. He moves up from vice president-engineering to the No. 2 position in the company. He was elevated to the engineering vice presidency in 1957.

Borg-Warner Executives

J. H. Ingersoll, president of the Ingersoll-Kalamazoo Division of Borg-Warner Corp., has announced appointment of Robert F. Schultz as executive vice president and manager of the division. At the same time, Ben A. Swennes was named vice president and director of engineering; Anthony S. Mrozek, vice president in charge of defense sales; and Kenneth Moseley, assistant secretary-treasurer.

M. R. McLary has been appointed vice president and manager, and R. L. Cain assistant secretary-treasurer, of Ingersoll Products Division of Borg-Warner.

Harvie Promoted By Willys

John H. Harvie, regional sales manager in the middle East for Willys-Overland Export Corp., has been promoted to division sales manager for the Far East with headquarters in Toledo. He will head "Jeep" sales efforts in 13 countries of the Far East. He succeeds the late Charles C. Altum.

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F. W. Bailey

E. O. Vetter

Bailey Joins J. B. Beaird

Fred W. Bailey has been named general products sales representative of The J. B. Beaird Co., Inc., Shreveport, La. He will work with Beaird engineers to develop special pressure vessels in addition to other assignments.

Transfers To Venezuela

Alan H. Brown, who has been on special assignment for the past year with Tretolite Co. division of Petrolite Corp. at the company's plant and main offices in St. Louis, Mo., has been assigned to eastern Venezuela as field engineer with South American Petrolite Corp.

Lee C. Moore Appointment

Appointment of Ray T. Rigney as field service manager has been announced by Lee C. Moore of Tulsa, Okla. Assistant plant superintendent for eight years, Mr. Rigney will direct all field service operations and personnel.

R. T. Rigney

C. M. Wanner

Joins Drilexo

Charles M. Wanner, consulting geologist, is joining Drilling and Exploration Co. Inc. as assistant to George H. Thomas, manager of the company's Eastern Hemisphere operations. Mr. Wanner is a graduate of the University of Wyoming, and was formerly employed by Creole Petroleum Corp. and the Carter Oil Co. prior to going into the consulting business in Rawlins, Wyo. He closed his consulting business to accept his present position.

Aero Design Appointments

In a company reorganization, Aero Design and Engineering Co., Oklahoma City, has announced a number of sales management appointments. E. B. Charles has been appointed general sales manager; and Tom Sim, export sales manager.

Roots-Connersville At Houston

Roots-Connersville Blower Division of Dresser Industries Inc., Connersville, Ind., is establishing a new district sales office at 1619 Ovid Street, Houston 10, Texas. Manager of the new office will be Daniel Fulton.

Seiscor Mfg. Formed

Formation of a new manufacturing division, Seiscor Manufacturing Co., has been announced by G. H. Westby, president of Seismograph Service Corp. Dr. J. E. Hawkins, SSC vice president, will assume additional duties as vice president and manager of the new division. Dr. Hawkins said Seiscor Manufacturing Co. has been set up to provide engineering and production facilities and precision equipment to the oil and other industries. Seiscor will also handle the research, development, and manufacturing needs of SSC.

Texas Instruments V.P.

E. O. Vetter, general manager of the industrial instrumentation division, has been named an assistant vice president of Texas Instruments Inc., with headquarters in Houston. Before assuming his present position in 1957, Mr. Vetter was vice president, administration, of Geophysical Service Inc., wholly-owned TI subsidiary.

Charles K. Fennel has joined Texas Instruments as manager of marketing techniques. Since 1940, he was in field sales and marketing for General Electric Co.

Solvay Process Changes

Appointment of Daniel Post as market research analyst for Solvay Process Division, Allied Chemical Corp., has been announced. A chemical engineering graduate of Columbia, he joined Allied Chemical's nitrogen division in 1950.

Lester B. Gordon has retired as vice president of Solvay Process Division.

Completes Three Foreign Jobs

Three major foreign orders have been completed by associated and subsidiary companies of Dresser Industries Inc., Dallas. These deliveries have included the largest drilling rig ever constructed in France; two highly mobile rigs of American design and British and French manufacture, destined for drilling in Iraq, and a giant mobile rig especially designed for use in the Libyan desert.

McCullough Tool Appointments

McCullough Tool Co. has announced several personnel changes in the company's eastern division. W. H. Harvey has been promoted to district sales and service manager of the Victoria, Texas, district. David M. Glass has transferred to Victoria, Texas, as district sales representative. A. D. Wilson is now at Breckenridge, Texas, as district sales representative; and Charles A. Marion is at Luling as southwest area salesman. Bill Rimes has been appointed district sales representative at New Iberia, La.

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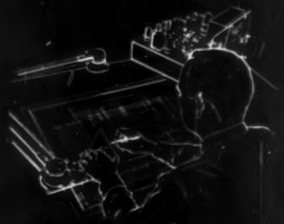

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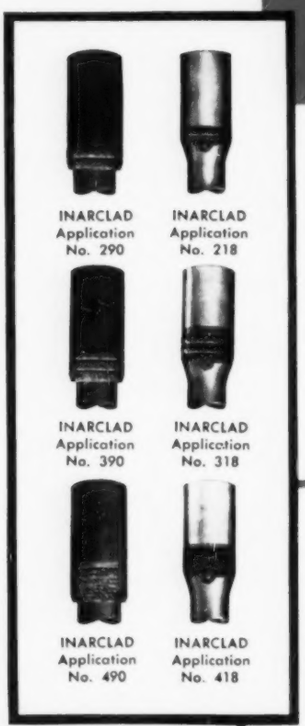
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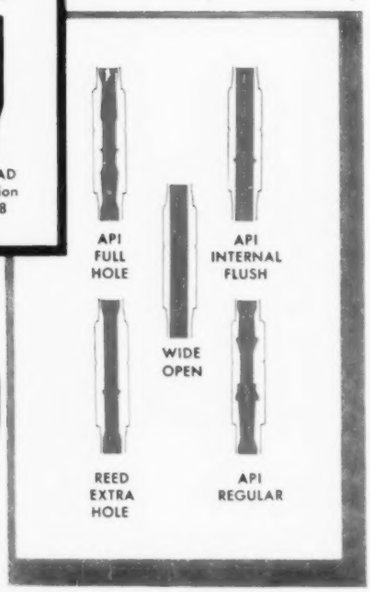
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